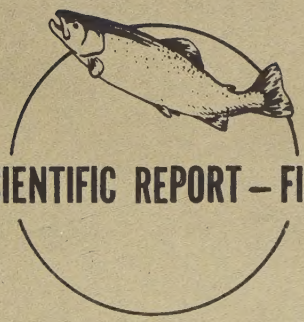
Longline Fishing for Tuna in the Central Equatorial Pacific, 1954



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UNITED STATES DEPARTMENT OF THE INTERIOR
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Explanatory Note

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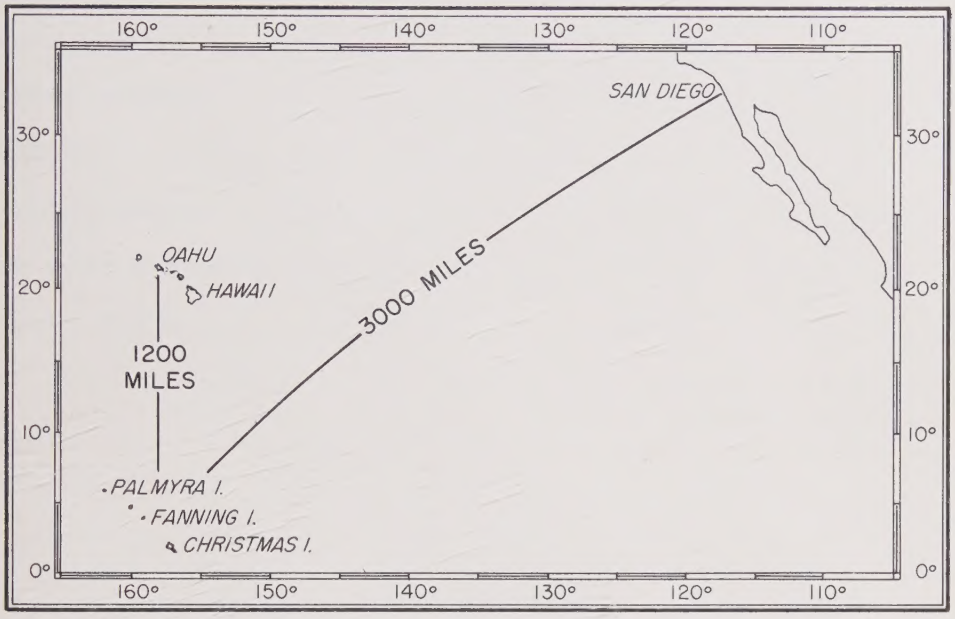

LONGLINE FISHING FOR TUNA IN THE CENTRAL EQUATORIAL PACIFIC, 1954

By

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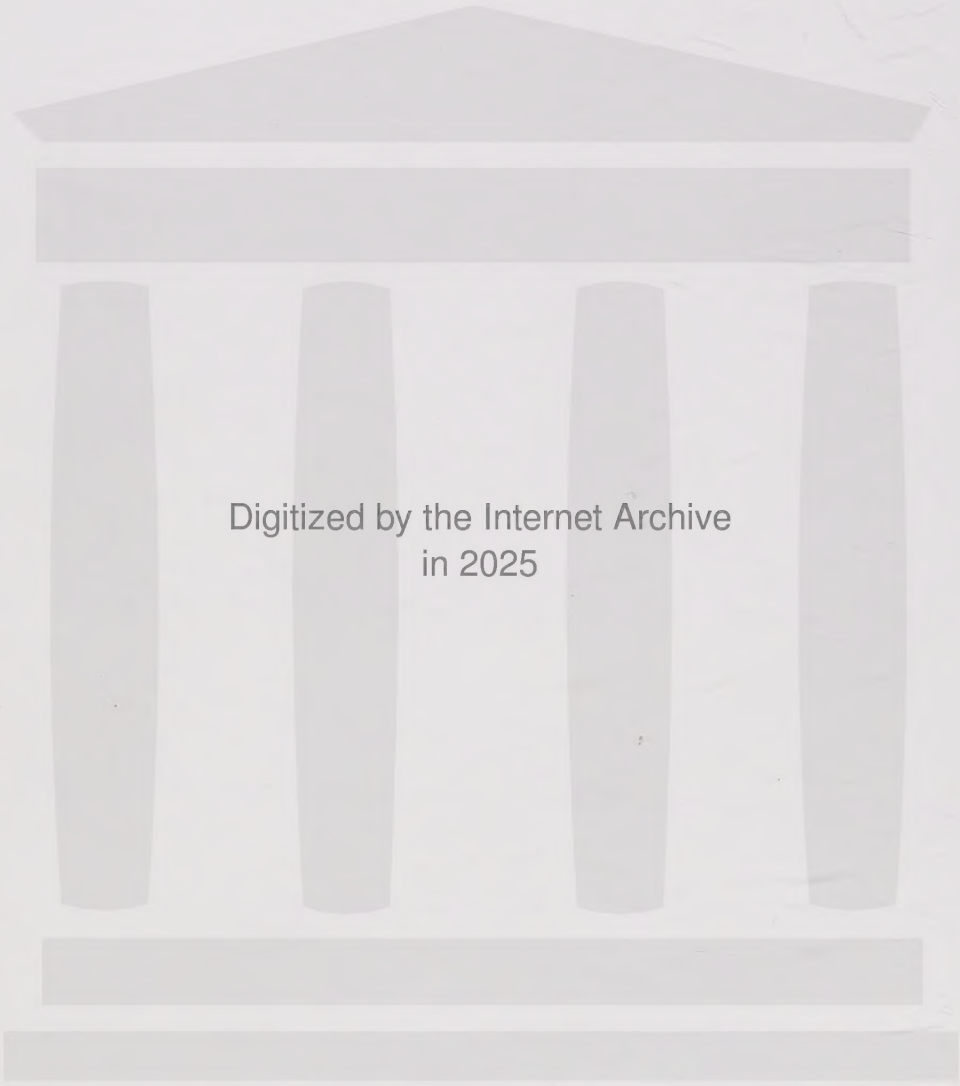

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One of the chief goals of the Pacific Oceanic Fishery Investigations (POFI) is to evaluate the equatorial Pacific tuna resources and to make the results of this appraisal available to American fishermen. In order to locate the regions of greatest tuna abundance and define their boundaries it has been necessary to do experimental fishing throughout vast areas of the equatorial Pacific. Our principal sampling tool has been the longline, which is used commercially to great advantage by the Japanese. Our research program has also of necessity included an evaluation of the longline method and of means of increasing its efficiency.

The present report is the fifth in a series and includes information obtained during experimental and commercial operations in the equatorial area in 1954. The earlier reports (Murphy and Shomura 1953a, 1953b, 1955, and Shomura and Murphy 1955) included processed data from cruises of 1950 through 1953, with some information from Japanese commercial fishing operations. The highlights of the 1954 fishing are:

(1) First commercial effort by American fishermen based on POFI research.

(2) First use of steel-mainline gear.

(3) Continued fishing for nearly 1 year in the Line Islands area, mainly near Christmas Island.

(4) Sharp difference in seasonal catch rates from previous years.

Longline catch statistics for the central equatorial Pacific during 1954 came from many sources. There were 2 POFI research cruises and 11 fishing trips by 6 American commercial vessels to the central equatorial region during the year. The John R. Manning (cruise 20) operated entirely within the Line Islands area; the Charles H. Gilbert (cruise 15) fished three north-south lines of stations, one close to Baja California at 119°W. longitude, one that crossed the Equator on 110°W. longitude, and a third which crossed the Equator on 155°W. longitude. The American commercial vessels operated in the vicinity of the Line Islands. Two of the commercial cruises made during 1954 were of immediate interest to the fishing industry so a general account of the venture was published (Iversen and Murphy 1955). In addition, longline fishing was initiated at American Samoa. The overall operation from January to April 1954 was reported by Van Campen (1954); the catch rates will be discussed in this report. Lastly, we have utilized the available data from Japanese longline fishing near the Equator.

In order to avoid needless repetition the present report does not include as detailed an analysis of the 1954 fishing results as was presented for the years 1950 through 1953 in the four previous numbers of the series. For instance, little space will be devoted in this report to the discussion of tuna other than yellowfin since other species were not taken in sufficient quantity to be of commercial interest. Operational details and the complete catch records for fishing cruises during 1954 are given in the Appendix. For the sake of simplicity, only the vernacular names of the various species in the catch will be used in this report. The scientific name for each species is listed in table 1 of the Appendix.

ACKNOWLEDGMENTS

Appreciation is extended to the captains and crewmen of both the commercial and POFI vessels for their cooperation and to the scientific personnel who made the observations, in many instances under adverse conditions. Deserving of special thanks are the following commercial vessel captains and owners: S. Jangaard, L. Jangaard, A. Ottness, E. Oswald, H. Sperling, and J. Parsons. The bathythermograph temperature sections and the Christmas Island temperature graph were prepared by T. S. Austin.

METHODS OF COLLECTION AND ANALYSIS OF DATA

The nature and extent of our observations varied during 1954. On the two POFI experimental cruises observations on the catch and fishing operations were obtained by trained personnel. The commercial vessels carried only a single government observer or none at all; in the latter case the vessel captain recorded information in a log provided by POFI (fig. 1).

PACIFIC OCEANIC FISHERY INVESTIGATIONS
LONGLINE FISHING LOG

Vessel _____ Noon position _____ (Lat.) _____ (Long.) Dir. of set _____ Date _____

Noon: Wind force _____ Wind direction _____ RPM of set _____

TIME OF SETTING AND HAULING

First basket set	Last basket set	First basket hauled	Last basket hauled

GEAR

Fabric	
Number baskets set	Number baskets lost
Wire	
Number reels set	Number reels lost

At the first day's fishing sketch one basket or reel of each type of gear used. Record any modifications of gear on this form.

Bait: Kind(s) _____

Bait hooking method: Single _____ Double _____ (Check one)

Bait condition: Good _____ Fair _____ Poor _____ (Check one)

CATCH

Species	Number not shark bitten	Number shark bitten	Approx. average weight	Remarks
Yellowfin				
Bigeye				
Skipjack				
Albacore				
Black marlin				
White marlin				
Striped marlin				
Sailfish				
Sharks				

Recorder: _____ 11/3/54

Figure 1.--Pacific Oceanic Fishery Investigations' Longline Fishing Log.

Also, certain facilities and equipment, such as a bathythermograph winch, were not available on the commercial boats. As a result, the information from this source was not as complete as that from the POFI research vessels.

There were differences in the gear used from cruise to cruise both in respect to design and materials. To some extent these variations affected the catch rates. The longline gear with fabric mainline had as few as 6 and as many as 15 droppers per basket. Shomura and Murphy (1955) found that catch rates of yellowfin tuna in terms of fish per 100 hooks taken on gear with 11 droppers per basket should be multiplied by 1.52 to make them equivalent to catch rates on gear with 6 droppers per basket. Catch rates are given in terms of 11-hook gear, except in our comparison of American and Japanese fishing results at different longitudes. In this case rates of American vessels have been converted to 6-hook equivalents to make them comparable to the Japanese catch rates. The length of the droppers on 6-hook gear used on cruise 15 of the Charles H. Gilbert was 10 fathoms as compared with the usual 3 fathoms, but the difference is not believed to have markedly altered the catch rates, for the efficiency of long and short droppers has been compared and no significant difference demonstrated (Shomura and Murphy 1955). On this same cruise both 1- and 10-fathom float lines were used on some stations (tables 6 and 7 - Appendix), but previous experiments have indicated no significant difference in yellowfin catch rates resulting from the use of different length float lines (Murphy and Shomura 1953b).

Longline gear with the mainline of wire rope was used on two commercial ventures of the Commonwealth (cruises 1 and 2), Oceanic and Brothers (cruises 1 and 2), and one experimental fishing cruise of the John R. Manning (cruise 20). The steel gear was introduced to increase the efficiency of operation of longline fishing. Steel mainline can be spooled on a reel rather than coiled in baskets, which results in a very considerable saving of labor. There is some

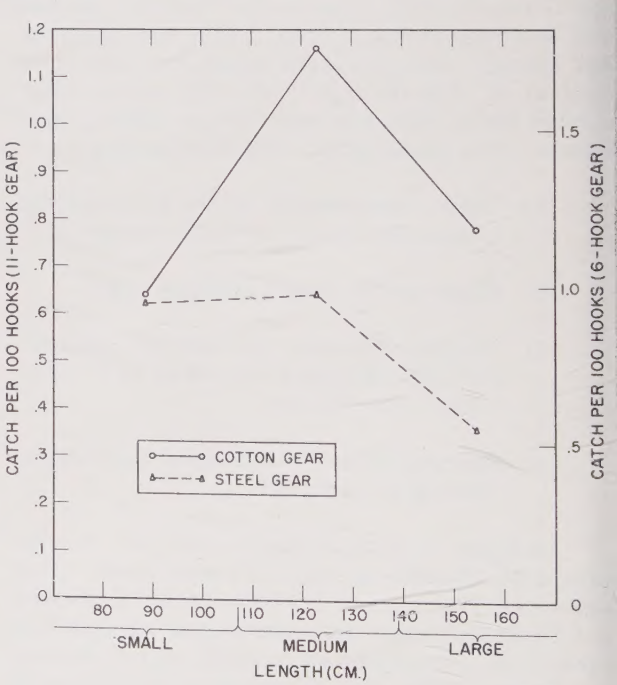

Figure 2.--Comparison of steel and cotton gear yellowfin catch rates by size groups, John R. Manning cruise 20.

indication, however, that the steel gear has a lower catch rate than fabric gear. A comparison of the two, made on John R. Manning cruise 20, shows that the steel line caught about the same number of small yellowfin, but that it caught relatively fewer medium and large yellowfin than the fabric gear (fig. 2). The steel gear probably does not offer the resiliency to the struggles of the fish that the fabric gear does, hence a higher proportion of the larger tunas escape.

The amount of shark damage varies considerably from cruise to cruise. The numbers of shark-damaged yellowfin are included in calculations of abundance for each cruise, but, of course, should not be counted when calculating the number of marketable fish.

VESSEL EFFICIENCY

It has been frequently observed that with equivalent fishing effort some vessels are able to produce good catches while others fishing under seemingly the same conditions and in the same general area do poorly. The reasons for this, perhaps, lie in the skill, experience, etc., of the fishermen involved. In an intensive fishery individual differences in experience will be smoothed out in the seasonal or annual averages. In 1954, only eight vessels took part in longline fishing in the area of study, and one of these made only a single trip; also the waters, and, in some instances, the fishing method, were unfamiliar to the fishermen. Hence it is possible that some of the variation among catches made at different times of the year resulted from differences among vessels and not entirely from a seasonal variation in the abundance of yellowfin.

Despite this possibility, it appears that differences among vessels did not seriously affect the catch rates, since there were only gradual changes in the catch rates between consecutive cruises, and when two or three vessels fished simultaneously, as did the North American and the Alrita, the catch rates were in general similar (fig. 3). The 95-percent fiducial limits estimated by Murphy and Elliott (1954) for longline catch rates, if assigned to the rates of each vessel, would doubtless overlap.

Differences among local fishing areas could also affect the catch rates. In Hawaii, for example, Otsu (1954) found that certain longline boats fished in a certain area whether productive or not, while others fished in areas which were known to be the most productive at a particular season. On the basis of the meager data available from the Line Islands area it appears that yellowfin move around these rather small islands in a more or less random manner. This, coupled with the fact that the vessels moved about from day to day, makes it very doubtful that location of fishing biased the catches.

YELLOWFIN ABUNDANCE

Latitudinal Variation

In February to April 1954 the Charles H. Gilbert (cruise 15) occupied fishing stations on

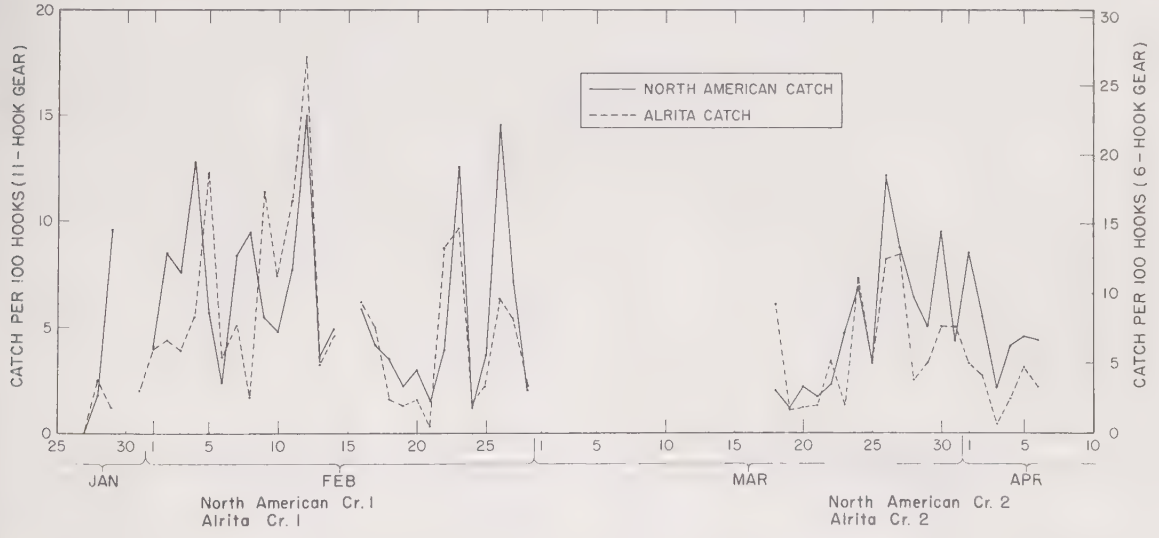

Figure 3.--Daily variability of yellowfin catch between the North American and the Alrita in the Line Islands.

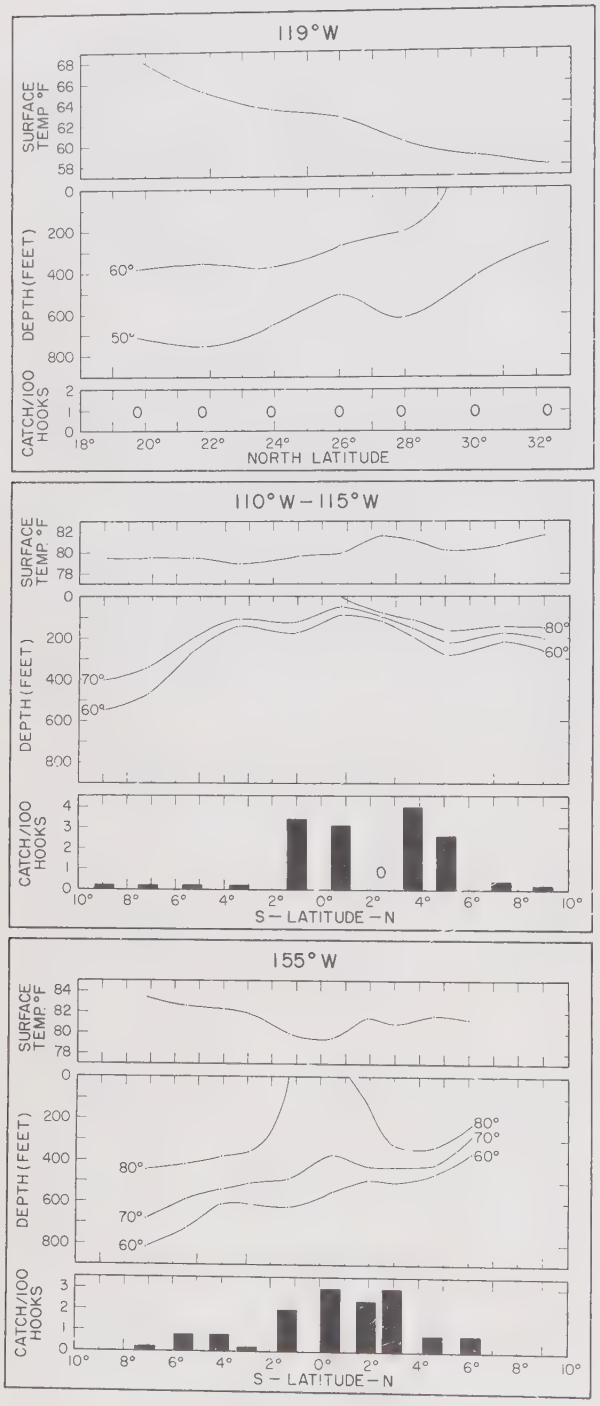

Figure 4.--Variation of yellowfin catches with latitude and temperature on three station lines along 119°W., 110°-115°W., and 155°W. longitude; Charles H. Gilbert cruise 15, February to April. [If no yellowfin were taken a zero is shown at that latitude.]

three north-south lines in the eastern and central Pacific. On this cruise 6- and 11-hook gear was fished simultaneously; therefore, 6-hook catch rates have been converted to 11-hook equivalents and averaged with the 11-hook catch rates. The variation of yellowfin catches with latitude and temperature is shown in figure 4. The first series on 119°W. longitude extending from 33°N. to 20°N. latitude yielded no yellowfin. The section on 110°-115°W. longitude, from 10°N. to 10°S. latitude produced the best catches (>2 yellowfin per 100 hooks) between 6°N. and 1°S. latitude. Running north on 155°W. longitude the highest catch rates (>2 yellowfin per 100 hooks) were made between 2°S. and 3°N. latitude. Most of these stations were outside the influence of land (more than 60 miles) so that the catch rates are readily comparable with previous results from the open ocean. The results from along the Equator are consistent with past experience. Shomura and Murphy (1955) found that the center of abundance of yellowfin at several longitudes was at or a little north of the Equator during 1953.

Longitudinal Variation

The Japanese carried out extensive long-line fishing in the equatorial Pacific during 1954. Records of their catches are available (Nomura 1954-55) for each month of the year. It is difficult to compare these data with ours because the Japanese in general fished farther to the north during many months of the year (probably in search of better bigeye catches) than did U.S. fishermen or the POFI research vessels. Nevertheless, certain aspects of seasonal and geographic variation are susceptible to analysis.

The catch rates of American and Japanese vessels are plotted in terms of 6-hook gear for each month of the year in figure 5 for latitudes 11°S. to 10°N. (Table 18 in the Appendix lists the results of the Japanese fishing.) Considering the Japanese data for the area west of 170°W. longitude, the seasonal trend in catch rates is the same as described by Shomura and Murphy (1955), i.e., low catch rates, less than 2 yellowfin per 100 hooks from January to May, slightly higher catch rates in June and July of 2-4 yellowfin per 100 hooks, with a decrease again from August to December to less than 2 yellowfin per 100 hooks.

In comparing the catches west of 170°W. with those of the Line Islands area during 1953, Shomura and Murphy (1955) found evidence of an east-west shift in the equatorial yellowfin population. During 1954 there was some indication of a similar shift in the center of abundance.

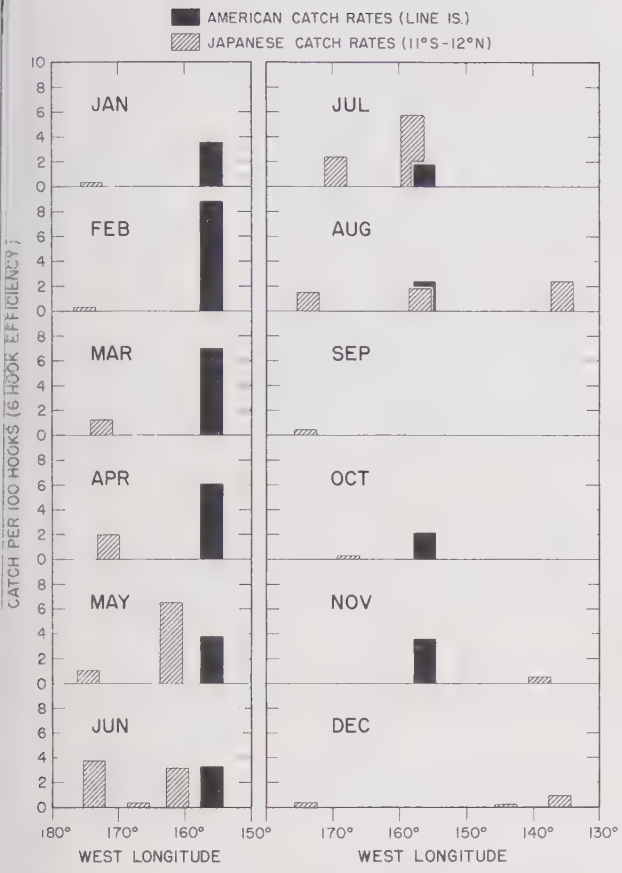

Figure 5.--Catch rates of yellowfin from the equatorial Pacific (11°S. - 10°N. latitude) obtained by American and Japanese vessels during 1954.

When the catches were high west of the Line Islands area (around 160°W.) they were lower in the vicinity of the Line Islands and conversely (fig. 5).

During the month of July 1954 Japanese vessels fishing near the Line Islands area experienced markedly higher catch rates than the American vessels. This is difficult to evaluate in view of the wide variability in the very few samples obtained by American vessels during July. However, the Japanese did most of their fishing south and somewhat west of the Americans and used fabric instead of steel gear.

Line Islands

General: A seasonal trend can be seen in the yellowfin catch rates from the vicinity of the Line Islands during 1954 (fig. 6). Starting with high catch rates in February, there was a gradual decrease to a very low level during the latter part of July, early August, and during October. During November there was a slight increase over the summer months, but the rates remained considerably lower than those of the first few months of the year. The catch rates of the Japanese longline vessels based at Pago Pago, American Samoa, show a similar decline (fig. 7) during the early months of 1954 (Van Campen 1954).

This trend in catch rates during 1954 is sharply divergent from past observations, for Shomura and Murphy (1955) found that the greatest abundance in the Line Islands area occurred from July through September during 1951-1953. This dissimilarity in the seasonal trend of catch

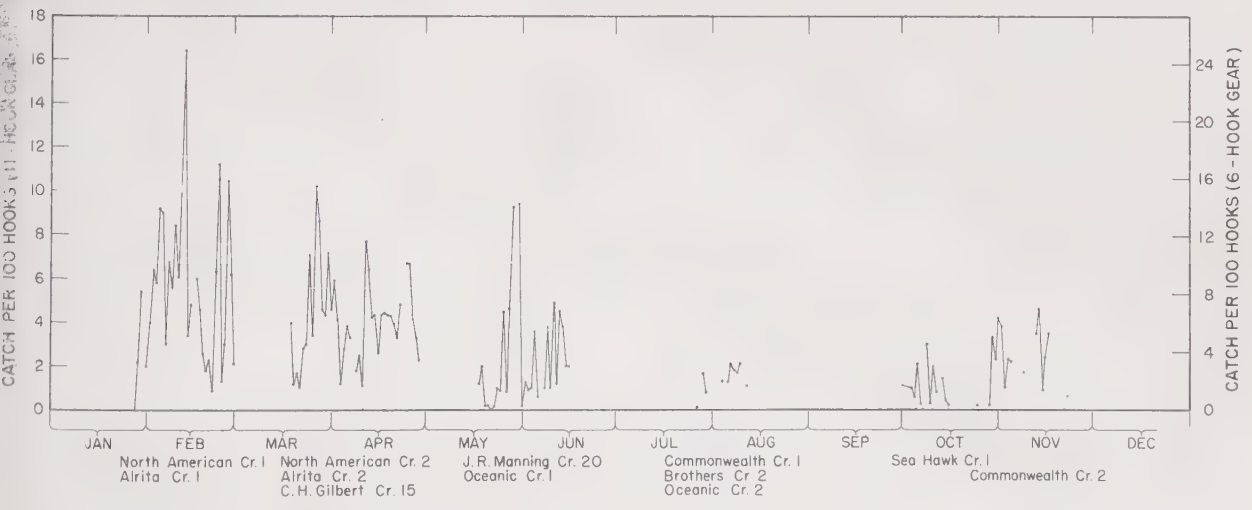

Figure 6.--Daily catch rates for yellowfin in the Line Islands during 1954.

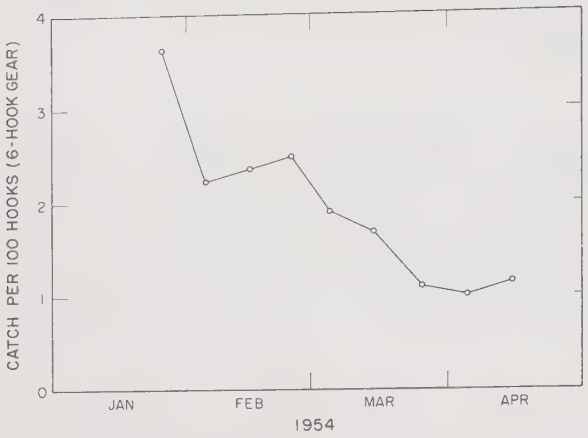

Figure 7.--Yellowfin catch rates by 10-day periods from 0° to 20°S. and 165°W. to 180° by vessels based at Pago Pago, American Samoa. /Data from Van Campen 1954./

rates is good evidence of a change in the abundance or distribution of the yellowfin. The possibility that this change is related to a change in the environment will be considered later.

Discussion of individual cruises: The results of concentrated fishing around Christmas Island by the North American and Alrita during January to March and March to May have already been discussed by Iversen and Murphy (1954). In the former period, yellowfin catches averaged 5.6 but ranged from 0 to 17.8 per 100 hooks for individual stations; in the latter period, they averaged 4.4 but ranged from 0.4 to 12.2 per 100 hooks. As shown by the summary of catch rates according to sectors (figs. 8 and 9) no one area seems to be significantly superior to the rest. We may conclude therefore that during this period the yellowfin were distributed in a somewhat random fashion. Only a few catches were made elsewhere in the Line Islands.

On John R. Manning cruise 20 (fig. 10), in May-June 1954, the best catch rates of 9.3 and 9.4 yellowfin per 100 hooks were made near Fanning and the poorest, 0 to 0.2 yellowfin per 100 hooks, near Palmyra.

On Oceanic cruise 1 (fig. 11), the fishing was generally poor, with an average catch rate of 0.9 for Christmas Island and an average of 1.5 for the seven stations in the vicinity of Fanning Island. The Brothers cruise 2 (fig. 12) occupied only four stations each at Fanning and Christmas Islands, with very low catch rates for both islands. The rate at Fanning averaged 0.9 and that at Christmas 1.0 yellowfin per 100 hooks. On Oceanic cruise 2 (fig. 13), only a single

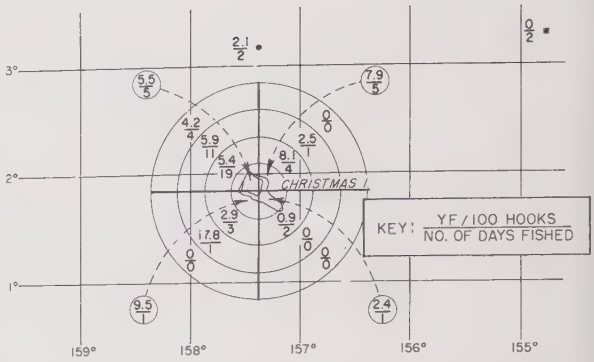

Figure 8.--Jangaard longline fishing (Alrita and North American catches combined), cruise 1, January-March.

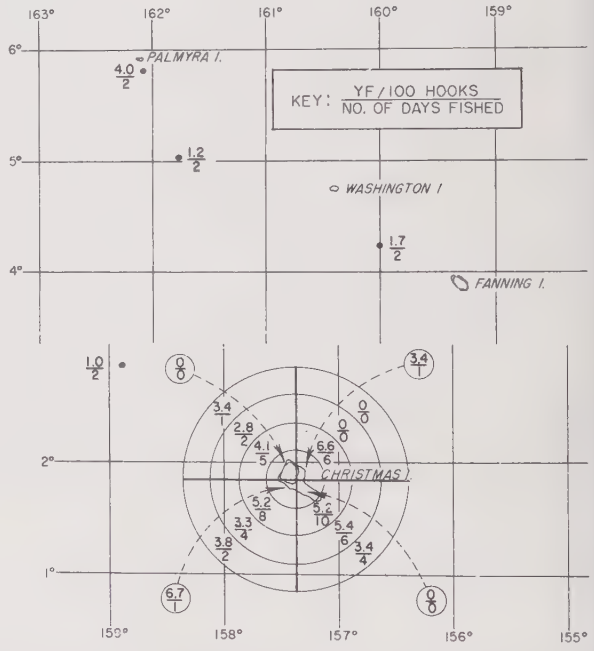

Figure 9.--Jangaard longline fishing (Alrita and North American catches combined), cruise 2, March-May.

station was occupied near Fanning; eight fishing days were spent in the vicinity of Christmas Island and show a high of 3.4 and a low of 0.2 yellowfin per 100 hooks.

On Commonwealth cruise 1 (fig. 14), fishing centered in the vicinity of Christmas Island. A high catch rate of 3.3 and a low of 0 yellowfin per 100 hooks were obtained. The Sea Hawk also fished in the vicinity of Christmas Island with poor results (fig. 15). Her best catch rate of 3.0 yellowfin per 100 hooks was made in the lee

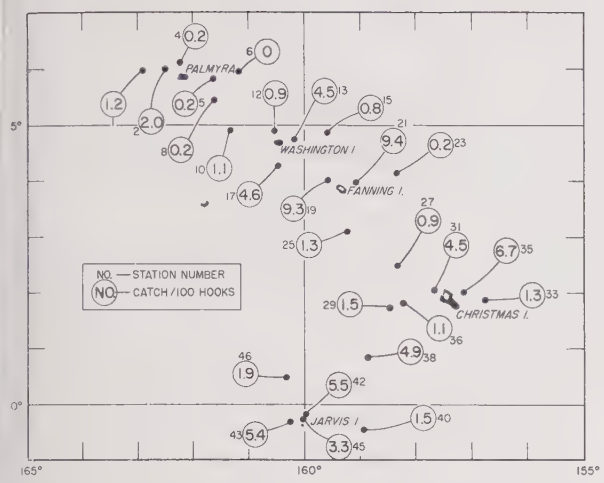

Figure 10.--John R. Manning longline fishing, cruise 20, May-June.

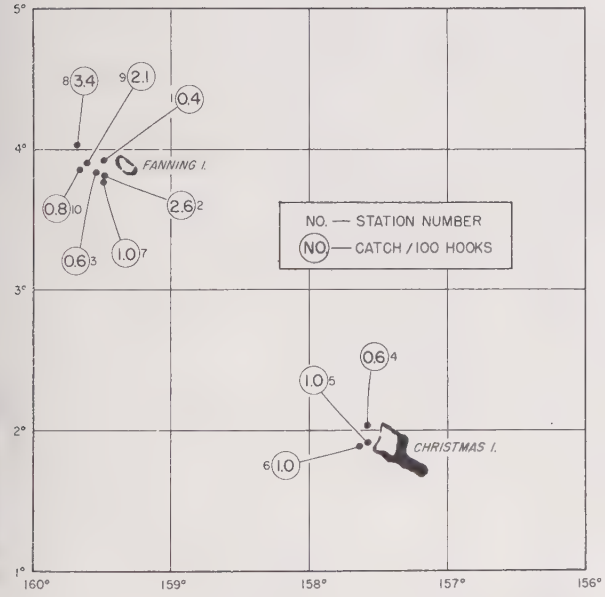

Figure 11.--Oceanic longline fishing, cruise 1, May-June.

of the island. On the second cruise of the Commonwealth fishing was improved, with high catch rates of more than 4 yellowfin per 100 hooks at both Christmas and Fanning Islands and one low catch rate at Palmyra of 0.6 yellowfin per 100 hooks (fig. 16). The average for Fanning Island, 3.0 yellowfin per 100 hooks, was only slightly higher than the average catch rate for Christmas Island, 2.3 yellowfin per 100 hooks.

Although it is difficult to summarize these rather variable and patchy results, we believe

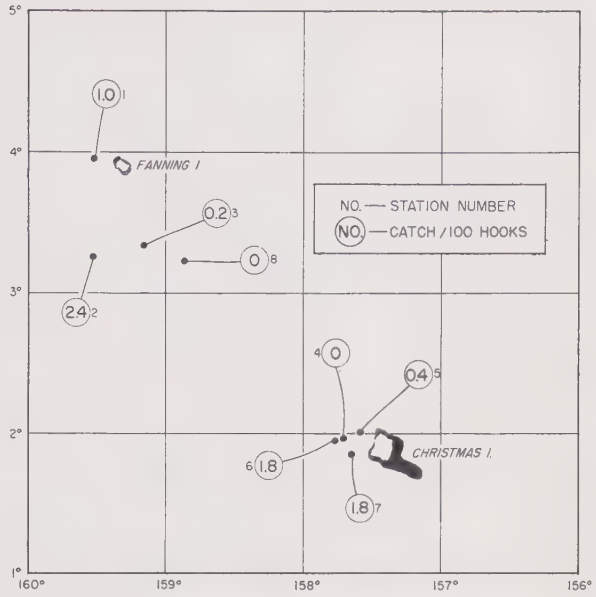

Figure 12.--Brothers longline fishing, cruise 2, July-August.

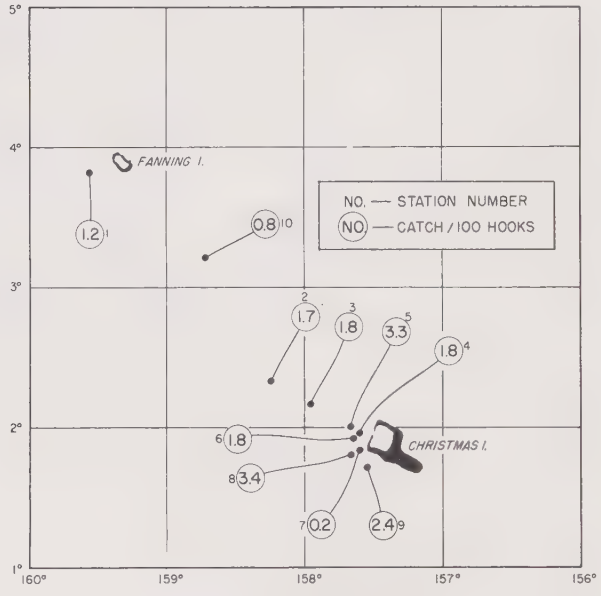

Figure 13.--Oceanic longline fishing, cruise 2, July-August.

they contain two important indications. First, the deep-swimming yellowfin do not appear to congregate on one side of an island, leeward or windward, in preference to the other; and second, although the data do not permit a proper comparison of differences among islands, slightly better catches were made in the vicinity of Fanning Island than at Christmas or the other areas fished (figs. 10, 11, 12, 16).

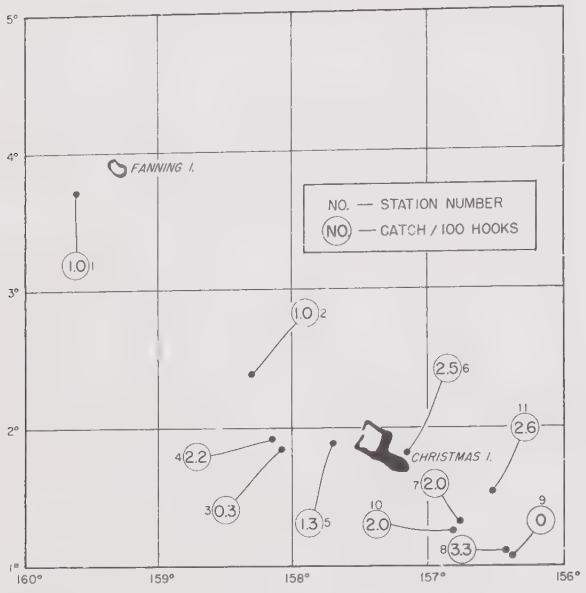

Figure 14.--Commonwealth longline fishing, cruise 1, July-August.

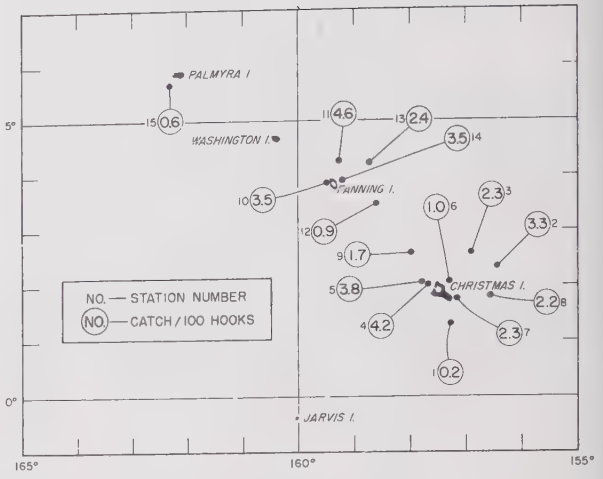

Figure 16.--Commonwealth longline fishing, cruise 2, October-November.

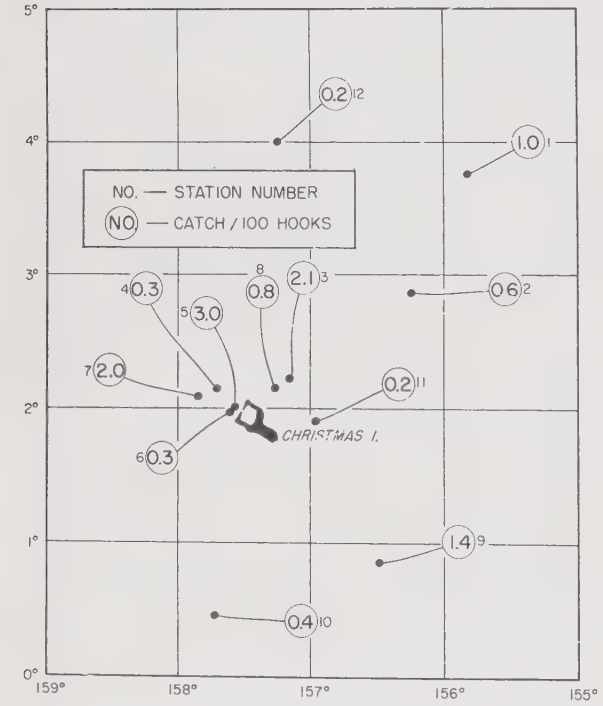

Figure 15.--Sea Hawk longline fishing, October.

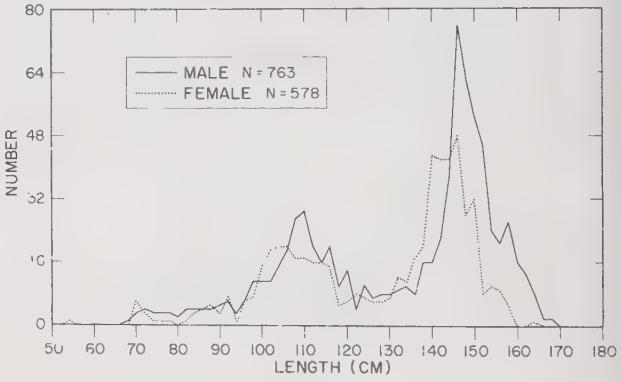

Figure 17.--Yellowfin size distributions by sex taken on fabric gear in the Line Islands area during 1954 (data in Appendix table 17).

YELLOWFIN CATCH COMPOSITION

There are no apparent differences in the sex ratio or size distribution between yellowfin caught during 1954 and those caught in past years (Murphy and Shomura 1955, fig. 11 and Shomura and Murphy 1955, fig. 11) that would help explain the decreased abundance during 1954 and the absence of the midsummer upswing in catch rates. As usual the males were predominant in number, especially in the very large fish (fig. 17).

OBSERVATIONS ON THE ENVIRONMENT

In conjunction with the experimental fishing, extensive observations were made on the sea temperature. In the long-term approach these observations are intended to help explain seasonal and annual fluctuations in catch rates of tuna. Tester (1956) points out a high positive correlation between sea temperatures and yellowfin catch. He does not regard the temperature change as the direct cause of the change in tuna abundance; rather, that temperature indicates the age of the water subsequent to upwelling. Since upwelling brings to the surface water low in temperature and high in nutrients, he regards the coolest water as newly upwelled and warmer water as water that has been longer at the surface and has remained in the area sufficiently long to permit tuna forage to develop in it.

Since November 1953 the U. S. Fish and Wildlife Service has obtained weather and hydrographic data from the weather station on Christmas Island. At that time instruments and aid were given to improve the station maintained by a plantation weather observer at the village of London on the lee (west) side of the island. Differences between observations made at the island station and in the open ocean are being examined. At present it appears that on-shore water temperatures are consistently lower than those off-shore, but they may provide an index of oceanic conditions.

Surface temperatures obtained at the Christmas Island station during 1954 show a trend generally similar to the trend in the catch rates of yellowfin (fig. 18). Both sea surface temperatures and yellowfin catch rates were relatively high early in the year and both were relatively low during the late summer and fall months.

Tester (1956, fig. 3) used yellowfin catches and temperatures collected in the equatorial Pacific over several years to define the temperature-yellowfin relationship. In this report we are dealing with a large number of observations taken within one year and all from the Line Islands area. Since the same interpretation can be given to the two somewhat dissimilar lots of data, the hypothesis that there is a significant relationship between the temperature of the water and the abundance of yellowfin tuna appears reliable.

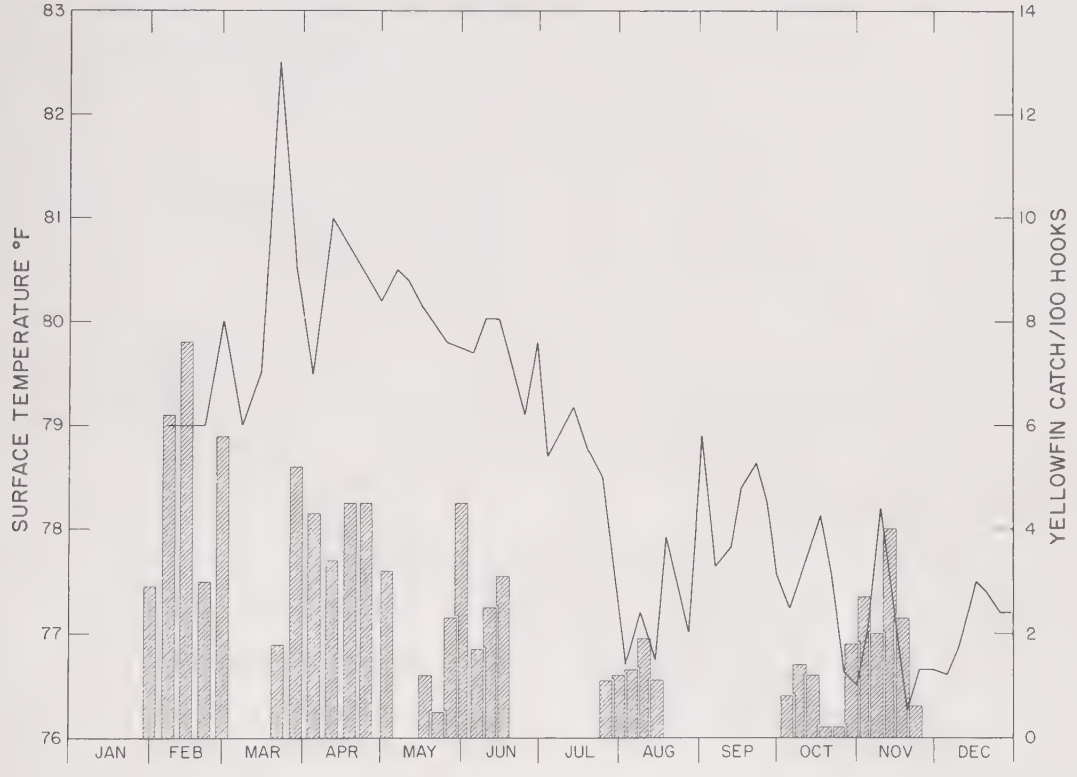

Figure 18.--Surface temperatures at Christmas Island and Line Islands yellowfin catches during 1954 by 5-day periods. [/] Only single weekly temperature observations are available through March 12. [/]

SHARKS AND SHARK DAMAGE

The depredation on hooked yellowfin tuna by sharks requires brief examination, since it affects the monetary return to fishermen from any longline venture. Not all tunas which are shark damaged are unsaleable, however, since some may be only superficially damaged and hence acceptable to canneries. Consequently, the records kept by POFI observers tend to exaggerate the loss from this source since the extent of damage to each shark-bitten fish was usually not evaluated.

The loss due to sharks during 1954 does not differ greatly from previous years. In 1954 an average of 20 percent of hooked yellowfin were damaged. One extreme occurred on a cruise of the Oceanic when 46 percent of the yellowfin caught were either partially mutilated or totally destroyed by sharks. The lowest figure for any cruise in 1954 was the 10 percent damage reported by the North American on cruise 1.

The relationship of the percentage of shark damaged to hooked yellowfin and the longline catch rates of all species of sharks (white-tipped, silky, great blue, and bonito) taken during 1954 in the Line Islands region is illustrated in figure 19.

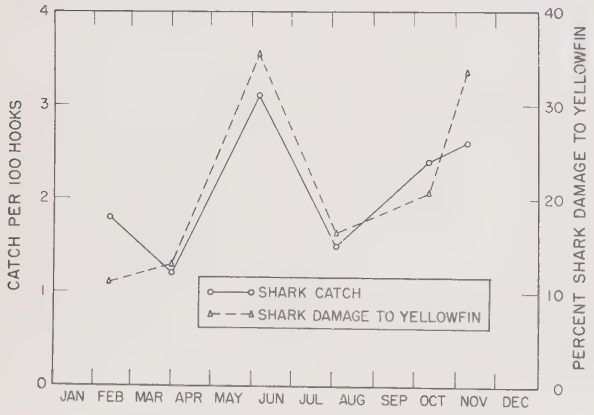

Figure 19.--Shark catch rates on longlines and percentage of shark damage to hooked yellowfin in the Line Islands area during 1954.

The plotted points are mid-points of fishing periods, and where two or more vessels fished together the average shark catch rate and shark damage are used. As would be expected the amount of shark damage varies directly with the shark catch rates. Shark catch rates, however, are not correlated with the abundance of yellowfin (compare figs. 19 and 6).

SUMMARY

1. There were thirteen longline fishing cruises to the central equatorial Pacific during 1954. Most of these were commercial ventures to the vicinity of the Line Islands.

2. The year 1954 marked some first events in the central equatorial Pacific: (1) the first commercial attempts to longline by American fishermen, (2) the first use of steel longline gear, and (3) first concentrated year-around fishing in the Line Islands area.

3. The seasonal trend of catch rates was lowest during August and October 1954, the period at which catch rates were highest for previous years.

4. The lack of distinct variation in yellowfin catch rates between different localities close to the Line Islands indicated a random distribution of the fish in respect to each individual island.

5. The sex ratio and size distribution in the yellowfin catch of 1954 were similar to the previous years.

6. A correlation between sea temperature and the catch of deep-swimming yellowfin was observed again in 1954, with the higher catch rates being associated with warmer surface temperatures.

7. The amount of shark damage to hooked yellowfin was about the same as in previous years and varied directly with the abundance of sharks.

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APPENDIX

Annotated List of 1954 Cruises

Vessels: North American and Alrita (Jangaard expedition)
Cruise No.: 1
Cruise period: January 12 to March 7, 1954
Gear: The longline gear used differed only slightly from the most recent 11-hook gear used by POFI (Mann 1955). The major differences were the lengthening of the mainline to 1620 feet and the addition of 4 extra droppers, making a total of 15 droppers per basket.

Vessels: North American and Alrita (Jangaard expedition)
Cruise No.: 2
Cruise period: March 13 to May 15, 1954
Gear: The gear used was identical with the gear used on the first Jangaard expedition.

Vessel: Charles H. Gilbert
Cruise No.: 15
Cruise period: February 18 to April 26, 1954
Gear: Equal numbers of POFI 6- and 11-hook cotton gear were fished at all stations. The lengths of the droppers were 10 fathoms on the 6-hook gear and 3 fathoms on the 11-hook gear. Ten-fathom float lines were used on both gear types except at stations 7-32, at which both 1- and 10-fathom float lines were used.

Vessels: Oceanic and Brothers
Cruise No.: 1
Cruise period: May 20 to June 23, 1954
Gear: The mainlines used by both vessels were constructed of 5/64" hard lay Hackensack stainless steel cable made up into reels 1600 fathoms in length. The reels of cable were joined by means of Brummel hooks. A pair of bullet swivels 1 fathom apart were inserted every 45 fathoms along the mainline. Two sets of 3 brass beads were pressed on to the mainline between the pair of swivels. The droppers were attached between the swivels and beads. The gear on the Oceanic was usually made up with 11 or 14 hooks between floats. The Brothers usually set her lines with 14 hooks between buoys.

The float lines were made up of 40-pound tarred manila line with an A-K snap on the end and were either 10 or 25 fathoms in length. The floats used were of two types. One was the regular metal oxygen tank used by POFI and the other was 16-

inch diameter Japanese glass balls covered with netting. The droppers consisted of 2-1/2 fathoms of 16-pound tarred hemp, 1 fathom of galvanized wire leader and 9/10 hook.

Vessels: Oceanic and Brothers
Cruise No.: 2
Cruise period: July 14 to August 21, 1954
Gear: The gear used was identical with the gear used on the first cruise of the Oceanic and Brothers.

Vessel: Commonwealth
Cruise No.: 1
Cruise period: July 14 to August 21, 1954
Gear: The gear used was essentially the same as the gear used by the Oceanic and Brothers, but differed in several details. The mainlines used by the Commonwealth consisted of 5/64", 3 X 7 stainless steel cable. The floats were large Japanese glass balls. The float lines consisted of 10 fathoms of 9 thread Plymouth Manila (hard lay). The droppers consisted of 2 fathoms of 6 thread buoy Manila, 1 fathom of galvanized wire leader, and a 9/10 tuna hook. One basket was made up of 14 hooks.

Vessel: John R. Manning
Cruise No.: 20
Cruise period: May 11 to June 23, 1954
Gear: Whenever possible, equal numbers of POFI 11-hook cotton and steel gear were used. Other construction details were identifical.

Vessel: Sea Hawk
Cruise No.: 1
Cruise period: October 3 to 20, 1954
Gear: Ten-hook cotton gear (POFI design - 15-fathom hook spacing).

Vessel: Commonwealth
Cruise No.: 2
Cruise period: October 28 to November 22, 1954.
Gear: Both cotton and steel gear were used. The steel gear was composed of 100 hooks per reel and the cotton gear, 8 hooks per basket (POFI design - 15-fathom hook spacing).

Table 1.--List of common and scientific names of fishes used in this report

White-tipped shark, Pterolamiops longimanus (Poey)
Silky shark, Carcharhinus floridanus Bigelow, Schroeder and Springer
Great blue shark, Prionace glauca (Linnaeus)
Bonito shark, Isurus glaucus Müller and Henle
Marlin, Makaira sp.
Sailfish, Istiophorus orientalis (Temminck and and Schlegel)
Wahoo, Acanthocybium solandri (Cuvier and Valenciennes)
Dolphin, Coryphaena hippurus Linnaeus
Yellowfin tuna, Neothunnus macropterus (Temminck and Schlegel)
Bigeye tuna, Parathunnus sibi (Temminck and Schlegel)
Skipjack, Katsuwonus pelamis (Linnaeus)
Albacore, Germo alalunga (Bonnaterre)
Lancet fish, Alepisaurus sp.
Barracuda, Sphyraena barracuda (Walbaum)
Red snapper, Lutjanus bohar (Forskål)
Opah, Lampris sp.
Sunfish, Mola mola (Linnaeus)
Truncated sunfish, Ranzania truncata (Gmelin)
Broadbill swordfish, Xiphias gladius Linnaeus
Pelagic sting ray, Dasyatis atratus Ishiyama and Okada
Shortnosed spearfish, Tetrapturus angustirostris Tanaka

Table 2.--Summary of fishing localities and catches on 15-hook gear, North American cruise 1

Sta.	Date	Position[1]		Number of hooks	Total catch							
					Yellowfin		Number of fish					
		Latitude	Longitude		Number	Per 100 h.	Big-eye	Alba-core	Skip-jack	Marlin	Shark	Miscellaneous
1	1/27*	3°20'N.	154°45'W.	375	0	0	1	-	-	-	6	1 lancet fish
2	1/28	2°18'N.	157°05'W.	618	11 (2)[2]	1.8	-	-	1	3	16	
3	1/29	2°04'N.	157°50'W.	356	34 (8)	9.6	2	-	-	-	14	
4	2/1 *	1°42'N.	157°38'W.	630	26 (6)	4.1	-	-	-	-	-	
5	2/2	1°58'N.	157°34'W.	657	56 (7)	8.5	-	-	-	1	20	1 dolphin, 1 wahoo
6	2/3	2°01'N.	157°33'W.	738	56 (6)	7.6	-	-	-	-	22	1 dolphin, 1 wahoo
7	2/4	1°55'N.	157°36'W.	718	92 (7)	12.8	-	-	-	1	20	2 sailfish, 1 sunfish, 1 wahoo
8	2/5	1°50'N.	157°36'W.	858	49 (6)	5.7	1	-	-	-	8	2 dolphin, 1 sailfish
9	2/6 *	1°40'N.	157°17'W.	670	16	2.4	2	-	-	-	16	3 red snapper, 1 wahoo
10	2/7	1°52'N.	157°35'W.	873	73 (18)	8.4	-	-	-	1	31	1 barracuda, 1 wahoo
11	2/8	1°47'N.	157°30'W.	800	76 (6)	9.5	1	-	-	1	16	2 wahoo
12	2/9 *	2°02'N.	157°58'W.	840	46 (6)	5.5	-	-	1	1	5	1 lancet fish
13	2/10*	2°11'N.	158°04'W.	1,035	50 (5)	4.8	-	8	2	1	10	1 wahoo
14	2/11*	2°06'N.	157°42'W.	1,050	81 (1)	7.7	-	3	-	1	-	
15	2/12*	2°02'N.	157°52'W.	1,050	158 (1)	15.0	1	2	-	-	-	
16	2/13*	2°03'N.	158°15'W.	750	27 (2)	3.6	-	-	1	-	4	
17	2/14*	1°52'N.	157°34'W.	690	34 (4)	4.9	-	-	-	-	3	
18	2/16	1°56'N.	157°42'W.	975	58 (5)	5.9	-	-	1	-	11	2 wahoo
19	2/17	2°01'N.	157°46'W.	887	37	4.2	-	-	1	-	7	
20	2/18	2°08'N.	157°52'W.	863	30 (3)	3.5	2	-	3	-	16	
21	2/19*	2°04'N.	157°30'W.	1,020	22 (6)	2.2	-	-	-	-	14	
22	2/20	1°29'N.	157°36'W.	730	22 (2)	3.0	-	-	2	1	9	
23	2/21*	1°30'N.	157°15'W.	870	13 (2)	1.5	-	-	-	-	1	
24	2/22	1°51'N.	157°08'W.	720	28 (3)	3.9	-	-	-	1	21	1 lancet fish, 2 wahoo
25	2/23*	1°57'N.	156°54'W.	780	98 (24)	12.6	1	-	-	1	19	
26	2/24*	2°00'N.	158°05'W.	900	11 (1)	1.2	-	-	10	-	2	
27	2/25*	2°09'N.	157°23'W.	780	29 (3)	3.7	2	-	-	-	19	
28	2/26*	1°56'N.	157°15'W.	840	123 (12)	14.6	-	-	-	-	12	3 wahoo
29	2/27*	1°55'N.	157°11'W.	990	70 (3)	7.1	-	-	-	-	20	
30	2/28*	3°10'N.	157°23'W.	690	14 (7)	2.0	-	-	-	-	27	1 wahoo
Total				23,753	1,440 (156)	177.3	13	13	20	13	369	
Average					48.0 (5.2)	5.9	0.5	0.4	0.7	0.4	12.3	

* Indicates days no count of hooks was maintained.

[1] Position where first basket set. [2] Numbers in parentheses are shark-damaged fish and are included in the adjacent daily catch.

Table 3.--Summary of fishing localities and catches on 15-hook gear (from log maintained by Lars Jangaard), Alrita cruise 1

Sta.	Date	Noon position		Estimated number of hooks	Total catch							
					Yellowfin		Number of fish					
		Latitude	Longitude		Number	Per 100 h.	Big-eye	Alba-core	Skip-jack	Marlin	Shark	Miscellaneous
1	1/27	3°20'N.	154°57'W.	390	0	0	3	-	-	-	6	
2	1/28	2°18'N.	157°20'W.	630	16 (1)[1/]	2.5	1	-	2	-	7	
3	1/29	2°10'N.	157°45'W.	930	11 (2)	1.2	1	-	-	-	15	
4	1/31	1°50'N.	157°40'W.	645	13 (2)	2.0	-	-	-	-	9	
5	2/1	1°50'N.	157°40'W.	600	24 (4)	4.0	-	-	-	1	12	
6	2/2	2°00'N.	157°35'W.	675	30 (3)	4.4	1	-	-	2	24	
7	2/3	2°00'N.	157°30'W.	750	29 (8)	3.9	-	-	-	-	25	
8	2/4	2°03'N.	157°32'W.	750	41 (5)	5.5	-	-	-	-	14	
9	2/5	2°05'N.	157°32'W.	900	111 (18)	12.3	-	-	-	-	33	
10	2/6	2°03'N.	157°32'W.	750	27 (2)	3.6	-	-	-	-	18	
11	2/7	2°03'N.	157°35'W.	900	46 (7)	5.1	-	-	-	1	6	
12	2/8	1°50'N.	157°35'W.	825	14	1.7	-	-	-	1	10	
13	2/9	2°06'N.	157°50'W.	900	103 (5)	11.4	-	-	1	-	12	1 sailfish
14	2/10	2°04'N.	158°10'W.	1,050	78 (3)	7.4	-	4	1	1	17	1 sailfish
15	2/11	1°51'N.	157°55'W.	1,050	115 (2)	11.0	2	4	-	-	12	
16	2/12	1°47'N.	157°55'W.	975	174 (1)	17.8	-	4	-	1	6	
17	2/13	2°00'N.	157°55'W.	825	26 (5)	3.2	-	-	-	1	9	1 wahoo
18	2/14	4 mi. off S.W. Pt., Christmas I.		825	38 (12)	4.6	-	-	-	-	26	
19	2/16	1°58'N.	157°45'W.	975	60	6.2	1	-	-	-	14	
20	2/17	2°05'N.	157°40'W.	900	45 (1)	5.0	1	-	2	-	10	
21	2/18	2°07'N.	157°50'W.	900	14	1.6	-	-	1	-	6	1 sailfish
22	2/19	2°03'N.	157°37'W.	900	12	1.3	-	-	-	1	12	
23	2/20	1°36'N.	157°30'W.	825	13 (2)	1.6	-	-	-	-	6	
24	2/21	1°25'N.	157°20'W.	870	3	0.3	-	-	-	-	5	
25	2/22	1°50'N.	157°07'W.	750	65 (27)	8.7	-	-	-	-	70	
26	2/23	1°50'N.	156°55'W.	750	73 (23)	9.7	-	-	-	-	46	
27	2/24	2°00'N.	157°58'W.	900	13 (2)	1.4	-	1	3	-	6	
28	2/25	5 mi. N.W. of N.W. Pt.		900	20 (7)	2.2	-	-	-	-	32	
29	2/26	2°00'N.	157°08'W.	945	60 (2)	6.3	1	-	1	-	5	
30	2/27	1°55'N.	157°10'W.	900	49 (7)	5.4	-	-	-	-	8	
31	2/28	3°14'N.	157°08'W.	675	15 (1)	2.2	1	1	-	-	-	
Total				25,560	1,338 (152)	153.5	12	14	11	9	481	
Average					44 (4.9)	5.0	0.4	0.4	0.4	0.3	16	

[1/] Numbers in parentheses are shark-damaged fish and are included in the adjacent daily catch.

Table 4.--Summary of fishing localities and catches on 15-hook gear, North American cruise 2

Sta.	Date	Noon position		Number of hooks	Total catch							
					Yellowfin		Number of fish					
		Latitude	Longitude		Number	Per 100 h.	Big-eye	Alba-core	Skip-jack	Marlin	Shark	Miscellaneous
1	3/18	5°43'N.	162°16'W.	405	8 (2)1/	2.0	-	-	-	-	47	
2	3/19	4°56'N.	161°53'W.	675	8 (2)	1.2	-	-	2	2	5	
3	3/20	4°10'N.	159°57'W.	647	14 (4)	2.2	-	-	2	1	12	1 broadbill, 1 lancet fish, 1 wahoo
4	3/21*	2°52'N.	158°56'W.	900	6	0.7	-	-	5	-	16	2 wahoo
5	3/22	2°02'N.	157°56'W.	864	20 (1)	2.3	-	-	2	-	7	1 lancet fish
6	3/23*	5 mi. W. of Christmas I.		750	35 (5)	4.7	-	-	1	-	34	
7	3/24	7 mi. E. of N.E. Pt.		869	60 (10)	6.9	-	-	-	3	16	1 lancet fish, 1 wahoo
8	3/25*	7 mi. E. of N.E. Pt.		975	32 (4)	3.3	-	-	-	1	17	1 wahoo
9	3/26	15 mi. E. of N.E. Pt.		959	117 (21)	12.2	-	1	2	1	11	1 wahoo
10	3/27*	15 mi. E. of S.E. Pt.		990	87 (15)	8.8	1	-	3	3	16	1 wahoo
11	3/28	15 mi. E. of S.E. Pt.		924	59 (36)	6.4	-	-	-	4	29	
12	3/29*	15 mi. E. of S.E. Pt.		975	49 (3)	5.0	-	1	-	3	6	
13	3/30	1°20'N.	157°10'W.	918	87 (13)	9.5	-	-	1	1	17	1 lancet fish
14	3/31*	1°06'N.	157°00'W.	990	43 (3)	4.3	-	-	-	1	10	
15	4/1	10 mi. W. of Sta. 14		918	78 (7)	8.5	-	-	-	3	9	
16	4/2	1°06'N.	157°33'W.	944	52 (4)	5.5	-	-	2	2	9	
17	4/3	1°26'N.	157°50'W.	951	20 (6)	2.1	1	-	-	-	3	1 lancet fish
18	4/4	1°31'N.	157°28'W.	943	39 (5)	4.1	-	-	-	1	3	
19	4/5*	1°31'N.	157°10'W.	990	45 (8)	4.5	-	1	1	1	17	1 dolphin
20	4/6*	1°25'N.	156°52'W.	960	42 (1)	4.4	-	-	10	1	8	
21	4/8*	10 mi. E. of N.E. Pt.		990	18 (2)	1.8	-	-	2	-	9	2 wahoo
22	4/9*	1°10'N.	156°41'W.	990	25 (2)	2.5	-	-	8	1	12	
23	4/10	1°05'N.	156°33'W.	957	11 (1)	1.1	-	-	1	-	20	
24	4/11*	1°38'N.	157°39'W.	990	76 (8)	7.7	-	1	5	-	17	
25	4/12	1°37'N.	157°47'W.	900	58 (19)	6.4	-	-	4	1	17	1 sunfish
26	4/13*	1°33'N.	158°03'W.	885	37 (3)	4.2	-	3	11	1	9	
27	4/14	1°30'N.	157°41'W.	908	62 (7)	6.8	-	-	1	-	11	
28	4/15*	1°28'N.	157°33'W.	990	58 (6)	5.8	-	-	6	1	6	
29	4/16	1°10'N.	157°33'W.	935	48 (7)	5.1	1	1	7	-	9	
30	4/17	1°20'N.	157°22'W.	990	22	2.2	3	-	-	2	8	
31	4/18	20 mi. W. of London		933	40 (7)	4.3	1	-	1	-	16	1 lancet fish
32	4/19*	1°58'N.	157°48'W.	750	32 (2)	4.3	-	-	-	-	12	1 wahoo
33	4/20	8 mi. W. of Christmas I.		937	55 (15)	5.9	-	-	-	1	13	
34	4/21*	2°04'N.	157°57'W.	990	33 (2)	3.3	-	1	-	-	13	
35	4/22*	1°30'N.	157°37'W.	990	48 (3)	4.8	1	-	-	3	7	
36	4/24	10 mi. S. of S.W. Pt.		934	63 (3)	6.7	-	1	-	1	8	

* Indicates days no count of hooks was maintained.

1/ Numbers in parentheses are shark-damaged fish and are included in the adjacent daily catch.

Table 4.--Summary of fishing localities and catches on 15-hook gear, North American cruise 2 (cont'd)

Sta.	Date	Noon position		Number of hooks	Total catch							
					Yellowfin		Number of fish					
		Latitude	Longitude		Number	Per 100 h.	Big-eye	Alba-core	Skip-jack	Marlin	Shark	Miscellaneous
37	4/25*	12 mi. S.W. of S.E. Pt.		990	66 (6)	6.7	-	-	-	2	9	
38	4/26	15 mi. S. of S.W. Pt.		884	36 (3)	4.1	-	-	-	-	9	
39	4/27	1°44'N.	156°23'W.	725	24 (5)	3.3	-	1	-	-	7	
40	4/28*	1°40'N.	155°09'W.	750	17 (2)	2.3	-	-	-	-	9	
Total				35,965	1,730 (253)	187.9	8	11	77	41	513	
Average					43.2 (6.3)	4.7	0.2	0.3	1.9	1.0	12.8	

* Indicates days no count of hooks was maintained.

Table 5.--Summary of fishing localities and catches on 15-hook gear (from log maintained by Lars Jangaard), Alrita cruise 2

Sta.	Date	Noon position		Estimated number of hooks	Total catch							
					Yellowfin		Number of fish					
		Latitude	Longitude		Number	Per 100 h.	Big-eye	Alba-core	Skip-jack	Marlin	Shark	Miscellaneous
1	3/18	4 mi. S. of Palmyra I.		660	40 (14)1/	6.1	3	-	-	1	30	1 wahoo
2	3/19	5°07'N.	161°50'W.	750	8 (2)	1.1	3	-	-	-	6	1 wahoo
3	3/20	4°18'N.	160°10'W.	675	8	1.2	-	-	2	-	8	
4	3/21	2°55'N.	158°54'W.	900	12 (1)	1.3	-	-	5	-	10	
5	3/22	2°15'N.	158°00'W.	900	31 (1)	3.4	-	3	-	-	13	
6	3/23	2°04'N.	157°35'W.	900	12 (1)	1.3	-	1	-	1	20	
7	3/24	1°58'N.	157°08'W.	900	66 (3)	7.3	-	3	-	1	10	
8	3/25	1°56'N.	157°16'W.	975	33 (1)	3.4	-	1	-	4	6	
9	3/26	1°56'N.	157°00'W.	1,110	91 (10)	8.2	-	-	1	2	8	
10	3/27	1°43'N.	157°00'W.	1,050	88 (2)	8.4	-	-	-	1	11	
11	3/28	1°46'N.	157°00'W.	1,050	29 (1)	2.8	-	-	-	3	10	
12	3/29	1°36'N.	156°35'W.	1,050	38 (7)	3.6	-	-	-	1	9	
13	3/30	1°21'N.	157°10'W.	1,050	52 (2)	5.0	-	-	1	-	7	
14	3/31	1°05'N.	157°17'W.	1,050	52 (3)	5.0	-	-	-	-	9	
15	4/1	1°01'N.	157°51'W.	1,050	35 (10)	3.3	-	-	-	-	18	
16	4/2	1°19'N.	157°04'W.	900	24 (2)	2.7	-	1	2	-	3	1 broadbill
17	4/3	1°26'N.	157°50'W.	975	4 (3)	0.4	-	-	-	1	3	
18	4/4	1°30'N.	157°16'W.	975	16 (3)	1.6	1	-	1	-	13	
19	4/5	1°45'N.	157°00'W.	975	30 (8)	3.1	-	-	-	-	16	
20	4/6	1°18'N.	156°55'W.	900	20 (6)	2.2	-	-	10	1	6	
Total				18,795	689 (80)	71.4	7	9	22	16	216	
Average					34.4 (4.0)	3.6	0.4	0.4	1.1	0.8	10.8	

1/ Numbers in parentheses are shark-damaged fish and are included in the adjacent daily catch.

Table 6.--Summary of fishing localities and catches on 6-hook gear, Charles H. Gilbert cruise 15

Sta.	Date	Noon position		Number of hooks	Total catch							
					Yellowfin		Number of fish					
		Latitude	Longitude		Number	Per 100 h.	Big-eye	Alba-core	Skip-jack	Marlin	Shark	Miscellaneous
1	2/19	32°19'N.	119°25'W.	114	-	-	-	-	-	-	9	
3	2/20	30°06'N.	119°43'W.	120	-	-	-	-	-	-	10	
5	2/21	27°54'N.	120°11'W.	180	-	-	-	-	-	-	58	
7*	2/22	25°58'N.	119°58'W.	180	-	-	-	-	-	-	2	3 opah
9*	2/23	23°54'N.	119°45'W.	180	-	-	-	-	-	-	-	1 opah
11*	2/24	21°47'N.	119°50'W.	180	-	-	-	-	-	-	1	4 opah
13*	2/25	19°47'N.	119°42'W.	179	-	-	-	-	-	-	-	1 dolphin
15*	3/3	08°59'N.	110°09'W.	180	1 (1)[1/]	0.6	-	-	-	2	7	1 dolphin
17*	3/4	07°20'N.	110°20'W.	180	1	0.6	-	-	1	1	5	2 sailfish
18*	3/5	05°04'N.	110°37'W.	178	4 (2)	2.2	2	-	-	-	14	1 sting ray
20*	3/6	03°44'N.	110°17'W.	171	7 (2)	4.1	4	-	-	-	3	
22*	3/7	02°26'N.	110°26'W.	179	-	-	-	-	-	-	3	4 lancet fish
24*	3/8	00°48'N.	110°55'W.	179	6	3.4	-	-	-	-	1	2 lancet fish
26*	3/9	00°59'S.	111°28'W.	150	10 (2)	6.7	-	-	-	-	2	
28*	3/10	03°22'S.	112°10'W.	149	1	0.7	1	-	-	-	-	
30*	3/11	05°17'S.	113°11'W.	150	-	-	-	-	1	-	1	
32*	3/12	07°08'S.	114°20'W.	142	1	0.7	19	-	-	-	-	
34	3/13	08°58'S.	114°48'W.	149	1	0.7	1	-	-	-	-	
36	3/15	09°20'S.	120°53'W.	150	1	0.7	3	1	-	1	-	
38	3/18	09°01'S.	131°23'W.	148	-	-	2	-	-	2	-	1 shortnosed spearfish
54	4/9	07°12'S.	155°16'W.	180	-	-	-	-	-	1	2	
56	4/10	05°34'S.	155°13'W.	179	4	2.2	-	1	-	-	1	
58	4/11	04°04'S.	155°21'W.	180	2	1.1	3	-	-	1	2	
60	4/12	02°56'S.	155°11'W.	178	-	-	2	1	-	-	2	
62	4/13	01°19'S.	155°08'W.	179	6	3.4	-	-	1	-	1	2 unident. tuna, 1 blackfish[2/]
64	4/14	00°25'N.	155°07'W.	176	9 (2)	5.1	-	-	-	1	2	
66	4/15	01°58'N.	155°16'W.	180	3	1.7	-	-	-	1	3	
68	4/16	01°48'N.	156°38'W.	179	11 (1)	6.1	-	-	-	-	3	
70	4/17	02°03'N.	157°48'W.	176	9 (2)	5.1	-	-	-	-	1	1 wahoo
71	4/20	02°55'N.	155°55'W.	179	7 (1)	3.9	-	-	2	-	4	
73	4/21	04°37'N.	155°05'W.	179	4 (1)	2.2	-	-	-	1	7	
75	4/22	06°03'N.	155°02'W.	180	3 (2)	1.7	1	-	-	-	4	
Total				5,383	91 (16)	52.9	38	3	5	11	148	
Average					2.8 (0.5)	1.6	1.2	0.1	0.2	0.3	4.6	

* Stations at which 1- and 10-fathom float lines were used.

1/ Numbers in parentheses are shark-damaged fish and are included in the adjacent daily catch. 2/ Globicephala sp.

Table 7.--Summary of fishing localities and catches on 11-hook gear, Charles H. Gilbert cruise 15

Sta.[1]	Number of hooks	Total catch							
		Yellowfin		Number of fish					
		Number	Per 100 h.	Big-eye	Alba-core	Skip-jack	Marlin	Shark	Miscellaneous
1	220	-	-	-	-	-	-	14	
3	220	-	-	-	-	-	-	17	
5	329	-	-	-	-	-	-	122	
7*	330	-	-	-	-	-	-	3	3 opah
9*	329	-	-	-	-	-	-	3	2 opah
11*	328	-	-	-	-	-	-	3	2 opah, 1 dolphin
13*	330	-	-	-	-	-	-	2	2 dolphin
15*	330	-	-	1	-	-	1	15	1 sailfish
17*	330	1	0.3	2	-	-	-	7	1 sailfish, 1 lancet fish, 1 wahoo
18*	325	12 (3)[2]	3.7	5	-	-	2	14	
20*	327	17 (6)	5.2	1	-	-	1	6	
22*	329	-	-	1	-	-	-	7	5 lancet fish
24*	327	13 (1)	4.0	-	-	-	-	2	2 lancet fish
26*	275	7	2.5	-	-	-	1	4	
28*	275	-	-	3	-	-	2	1	1 wahoo
30*	275	1	0.4	2	-	5	-	2	
32*	266	-	-	19	-	1	2	1	1 sting ray
34	273	-	-	-	-	-	-	-	
36	270	2 (1)	0.7	3	1	-	1	-	
38	274	-	-	1	1	-	1	-	
54	330	1	0.3	-	-	1	1	1	
56	329	1	0.3	-	1	1	-	1	1 wahoo
58	328	3	0.9	-	1	-	-	4	1 wahoo
60	326	1	0.3	-	2	-	-	1	
62	330	6	1.8	-	1	-	-	4	1 unidentified tuna
64	326	9	2.8	-	-	-	-	3	
66	328	3	0.9	-	1	1	-	4	1 sunfish
68	327	12	3.7	-	1	1	1	2	
70	314	24 (7)	7.6	-	1	2	-	7	
71	325	11	3.4	-	-	-	1	2	
73	319	1 (1)	0.3	1	-	1	-	4	
75	329	2	0.6	1	-	-	1	5	
Total	9,873	127 (19)	39.7	40	10	13	15	261	
Average		4.0 (0.6)	1.2	1.2	0.3	0.4	0.5	8.2	

* Stations at which 1- and 10-fathom float lines were used.

[1] Dates and positions of these stations given in table 6.

[2] Numbers in parentheses are shark-damaged fish and are included in the adjacent daily catch.

Table 8.--Summary of fishing localities and catches on steel gear, John R. Manning cruise 20

Sta.	Date	Noon position		Number of hooks	Total catch							
					Yellowfin		Number of fish					
		Latitude	Longitude		Number	Per 100 h.	Big-eye	Alba-core	Skip-jack	Marlin	Shark	Miscellaneous
1	5/17	5°58.0'N.	162°52.5'W.	323	6	1.8	-	-	-	-	4	
2	5/18	6°02.0'N.	162°27.5'W.	327	1	0.3	-	-	-	1	1	
4	5/19	6°07.5'N.	162°12.5'W.	323	1	0.3	5	-	-	-	4	
5	5/20	5°49.4'N.	161°36.4'W.	330	1 (1)[1/]	0.3	-	-	-	-	5	1 lancet fish
6	5/21	5°57.5'N.	161°11.0'W.	330	-	-	1	-	-	1	5	
8	5/22	5°26.5'N.	161°36.7'W.	326	-	-	-	-	-	-	2	
10	5/23	4°55.0'N.	161°19.0'W.	321	3	0.9	-	-	-	1	3	1 wahoo, 1 lancet fish
12	5/24	4°56.0'N.	160°32.0'W.	312	6 (3)	1.9	1	-	-	-	13	
13	5/25	4°45.3'N.	160°11.0'W.	320	13 (2)	4.1	-	-	-	-	24	
15	5/26	4°52.0'N.	159°35.0'W.	216	2	0.9	1	-	-	-	5	
17	5/27	4°17.0'N.	160°27.5'W.	215	1	0.5	-	-	-	-	1	1 broadbill
19	5/28	4°02.0'N.	159°34.2'W.	214	1	0.4	-	-	-	1	1	
21	5/30	3°58.5'N.	159°04.1'W.	214	25 (6)	11.7	1	-	-	-	3	
23	5/31	4°07.9'N.	158°20.5'W.	221	-	-	1	-	-	-	1	
25	6/1	3°04.1'N.	159°12.3'W.	219	3	1.4	-	2	-	-	2	
27	6/2	2°29.0'N.	158°21.9'W.	214	3	1.4	-	1	1	-	1	1 barracuda, 1 lancet fish
29	6/3	1°43.0'N.	158°27.5'W.	218	3	1.4	-	-	-	-	8	
31	6/4	2°03.1'N.	157°39.5'W.	207	14 (7)	6.8	-	-	-	-	10	
33	6/7	1°52.0'N.	156°47.8'W.	215	5 (1)	2.3	-	-	1	-	3	
35	6/8	2°01.4'N.	157°09.0'W.	213	14 (3)	6.6	-	-	-	-	1	
36	6/9	1°47.0'N.	158°15.7'W.	211	3 (1)	1.4	-	-	-	-	3	
38	6/10	0°50.5'N.	158°52.6'W.	210	3	1.4	-	-	-	-	14	
40	6/11	0°26.0'S.	158°56.9'W.	211	3	1.4	1	-	-	-	10	
42	6/12	0°13.5'S.	160°00.5'W.	197	13 (3)	6.6	-	-	-	-	17	1 wahoo
43	6/13	0°17.9'S.	160°16.0'W.	216	-	-	-	-	-	1	5	
45	6/14	0°13.2'S.	160°02.2'W.	217	4 (2)	1.8	-	-	-	-	11	
46	6/15	0°29.5'S.	160°19.2'W.	212	4	1.9	-	1	-	-	1	
Total				6,752	132 (29)	57.5	11	4	2	5	162	
Average					4.9 (1.1)	2.1	0.4	0.1	0.1	0.2	6	

[1/] Numbers in parentheses are shark-damaged fish and are included in the adjacent daily catch.

Table 9.--Summary of fishing localities and catches on 11-hook cotton gear, John R. Manning cruise 20

Sta.[1]	Number of hooks	Total catch							
		Yellowfin		Number of fish					
		Number	Per 100 h.	Big-eye	Alba-core	Skip-jack	Marlin	Shark	Miscellaneous
1	328	2 (1)[2]	0.6	-	-	-	-	2	1 lancet fish
2	321	12 (5)	3.7	-	-	1	1	17	
4	330	-	-	2	-	-	-	4	
5	272	-	-	-	-	-	-	1	2 barracuda
6	323	-	-	-	-	-	1	5	1 lancet fish, 1 leather-back turtle[3]
8	329	1	0.3	2	-	-	-	3	
10	325	4	1.2	-	-	-	-	-	1 wahoo
12	329	-	-	-	-	-	-	7	1 lancet fish
13	318	16 (10)	5.0	-	-	-	1	28	
15	438	3	0.7	-	-	-	-	8	1 wahoo, 1 lancet fish
17	433	29 (6)	6.7	-	-	-	-	8	
19	421	58 (23)	13.8	1	-	-	1	21	
21	327	26	8.0	-	-	-	-	9	
23	325	1	0.3	-	-	1	-	7	1 lancet fish
25	326	4	1.2	1	-	-	-	2	
27	328	2	0.6	-	-	-	-	2	
29	325	5 (2)	1.5	-	-	4	-	11	
31	322	10 (2)	3.1	-	-	-	-	14	
33	328	2 (1)	0.6	-	1	1	-	5	
35	325	22 (6)	6.8	-	1	-	-	21	
36	329	3 (1)	0.9	-	-	-	1	9	
38	316	23 (4)	7.3	-	-	-	1	12	
40	322	5 (2)	1.6	-	1	-	1	4	
42	328	16 (2)	4.9	-	-	-	-	8	
43	318	29 (8)	9.1	-	-	-	-	25	
45	323	14 (5)	4.3	-	-	-	1	17	
46	303	6	2.0	-	-	-	-	3	
Total	9,012	293 (78)	84.2	6	3	6	8	253	
Average		0.9 (2.9)	3.1	0.2	0.1	0.2	0.3	9.3	

[1] Dates and positions of these stations given in table 8.

[2] Numbers in parentheses are shark-damaged fish and are included in the adjacent daily catch.

[3] *Dermochelys schlegelii* (Garman)

Table 10.--Summary of fishing localities and catches on steel gear, Oceanic and Brothers cruise 1

Brothers[1/]

Sta.	Date	Noon position		Estimated number of hooks	Total catch							
					Yellowfin		Number of fish					
		Latitude	Longitude		Number	Per 100 h.	Big-eye	Albacore	Skipjack	Marlin	Shark	Miscellaneous
1	6/3	3°53'N.	159°29'W.	200	10 (8)[2/]	5.0	-	-	-	1	17	
2	6/4	3°55'N.	159°28'W.	300	13 (7)	4.3	-	-	-	-	22	
3	6/5	3°54'N.	159°32'W.	300	15 (6)	5.0	-	-	-	-	14	
4	6/7	1°58'N.	157°37'W.	No data								
5	6/8	2°02'N.	157°33'W.	400	16 (10)	4.0	-	-	-	-	24	
6	6/9	1°58'N.	157°37'W.	400	17 (10)	4.2	-	-	-	-	25	
7	6/11	3°53'N.	159°28'W.	200	21 (5)	10.5	-	-	-	-	6	
8	6/12	3°55'N.	159°28'W.	400	7 (5)	1.8	-	-	-	-	7	
9	6/13	3°58'N.	159°28'W.	400	11 (7)	2.8	-	-	-	-	15	
10	6/14	3°55'N.	159°30'W.	400	7 (3)	1.8	-	-	-	3	10	
Total				3,000	117 (61)	39.4	-	-	-	4	140	
Average					13.0 (6.8)	4.4	-	-	-	0.4	15.6	

Oceanic

1	6/3	3°55'N.	159°28'W.	279	1	0.4	-	-	-	-	3	
2	6/4	3°50'N.	159°28'W.	460	12 (6)	2.6	-	-	-	1	4	
3	6/5	3°51'N.	159°32'W.	456	3 (1)	0.6	-	-	-	-	7	
4	6/7	2°02'N.	157°35'W.	460	3 (3)	0.6	-	-	-	-	40	
5	6/8	1°56'N.	157°35'W.	378	4	1.0	-	-	-	2	9	
6	6/9	1°54'N.	157°37'W.	475	5 (3)	1.0	-	-	-	-	32	1 wahoo
7	6/11	3°50'N.	159°28'W.	475	5 (2)	1.0	-	-	-	1	10	
8	6/12	4°02'N.	159°25'W.	383	13 (9)	3.4	-	-	-	-	36	
9	6/13	3°55'N.	159°36'W.	482	10 (2)	2.1	2	-	-	-	6	
10	6/14	3°53'N.	159°39'W.	389	3 (1)	0.8	-	-	-	-	4	
Total				4,237	59 (27)	13.5	2	-	-	4	151	
Average					5.9 (2.7)	1.4	0.2	-	-	0.4	15.0	

1/ The data from the Brothers may not be entirely accurate. No detailed record was kept and the daily fishing log was filled out a few days later from memory by the captain of the Brothers.

2/ Numbers in parentheses are shark-damaged fish and are included in the adjacent daily catch.

Table 11.--Summary of fishing localities and catches on steel gear, Commonwealth cruise 1

Sta.	Date	Noon position[1/]		Estimated number of hooks	Total catch							
					Yellowfin		Number of fish					
		Latitude	Longitude		Number	Per 100 h.	Big-eye	Alba-core	Skip-jack	Marlin	Shark	Miscellaneous
1	7/26	3°43'N.	159°36'W.	300	3	1.0	-	-	-	-	2	
2	7/28	2°23'N.	158°19'W.	500	5 (1)[2/]	1.0	1	-	2	-	1	1 broadbill
3	7/29	1°51'N.	158°05'W.	600	2	0.3	-	-	-	1	10	
4	8/3	1°55'N.	158°10'W.	600	13 (2)	2.2	-	-	-	-	12	
5	8/4	1°54'N.	157°43'W.	600	8 (1)	1.3	2	-	-	-	14	2 dolphin
6	8/5	1°49'N.	157°10'W.	600	15 (3)	2.5	3	-	2	2	9	2 wahoo
7	8/6	1°19'N.	156°47'W.	500	10	2.0	-	1	2	-	8	1 wahoo
8	8/7	1°06'N.	156°27'W.	600	20 (3)	3.3	-	-	1	1	9	
9	8/8	1°05'N.	156°24'W.	200	-	-	-	-	-	-	12	
10	8/9	1°15'N.	156°40'W.	500	10	2.0	1	-	1	1	3	
11	8/11	1°32'N.	156°33'W.	500	13 (5)	2.6	-	-	1	-	7	
Total				5,500	99 (15)	18.2	7	1	9	5	87	
Average					9.1 (1.4)	1.6	0.5	0.1	0.8	0.4	8.2	

[1/] Position when first basket was hauled.

[2/] Numbers in parentheses are shark-damaged fish and are included in the adjacent daily catch.

Table 12.--Summary of fishing localities and catches on steel gear, Brothers cruise 2

Sta.	Date	Noon positon		Estimated number of hooks	Total catch							
					Yellowfin		Number of fish					
		Latitude	Longitude		Number	Per 100 h.	Big-eye	Alba-core	Skip-jack	Marlin	Shark	Miscellaneous
1	7/26	3°58'N.	159°30'W.	500	5 (1)[1/]	1.0	1	-	1	1	5	
2	7/28	3°15'N.	159°30'W.	500	12	2.4	-	-	1	-	7	
3	7/29	3°19'N.	159°09'W.	500	1 (1)	0.2	-	-	-	-	2	
4	8/3	15 mi. W. of London		200	-	-	-	-	-	-	3	
5	8/5	6 mi. W. of London		500	2 (1)	0.4	-	-	-	-	8	
6	8/6	15 mi. W. of London		500	9 (1)	1.8	-	-	-	-	6	1 sailfish
7	8/9	14 mi. S.W. of Bridges Pt.		400	7 (3)	1.8	-	-	-	-	13	
8	8/11	42 mi. S.E. of Fanning I.		100	-	-	-	-	-	-	1	
Total				3,200	36 (7)	7.6	1	-	2	1	45	
Average					4.5 (0.9)	1.0	0.1	-	0.2	0.1	5.6	

[1/] Numbers in parentheses are shark-damaged fish and are included in the adjacent daily catch.

Table 13.--Summary of fishing localities and catches, Oceanic cruise 2

Sta.	Date	Noon position		Estimated number of hooks	Total catch							
					Yellowfin		Number of fish					
		Latitude	Longitude		Number	Per 100 h.	Big-eye	Alba-core	Skip-jack	Marlin	Shark	Miscellaneous
1	7/26	9 mi. W. xS. of Fanning I.		600	7 (1)[1/]	1.2	-	-	1	-	7	
2	7/28	2°20'N.	158°14'W.	600	10	1.7	-	-	1	-	4	
3	7/29	30 mi. W. xN. of Christmas I.		600	11 (1)	1.8	-	-	1	-	8	2 dolphin
4	8/3	6 mi. N. W. of S. W. Pt.		600	11 (4)	1.8	-	-	-	-	22	
5	8/5	10 mi. W. of Christmas I.		600	20 (2)	3.3	-	-	-	-	12	
6	8/6	10 mi. W. xS. of Christmas I.		600	11 (4)	1.8	-	-	-	-	8	
7	8/7	3 mi. S.W. of Christmas I.		500	1 (1)	0.2	-	-	-	-	7	
8	8/8	6 mi. S.W. of Christmas I.		500	17 (2)	3.4	1	-	-	-	2	
9	8/9	8 mi. S. of Christmas I.		500	12	2.4	-	-	-	-	8	
10	8/11	50 mi. S.E. of Fanning I.		500	4	0.8	-	-	-	-	7	
Total				5,600	104 (15)	18.4	1	-	3	-	85	
Average					10.4 (1.5)	1.8	0.1	-	0.3	-	8.5	

[1/] Numbers in parentheses are shark-damaged fish and are included in the adjacent daily catch.

Table 14.--Summary of fishing localities and catches on 10-hook gear, Sea Hawk cruise 1

Sta.	Date	Noon position		Estimated number of hooks	Total catch							
					Yellowfin		Number of fish					
		Latitude	Longitude		Number	Per 100 h.	Big-eye	Alba-core	Skip-jack	Marlin	Shark	Miscellaneous
1	10/3	3°45'N.	155°50'W.	500	5 (1)[1/]	1.0	-	-	-	1	37	
2	10/4	2°55'N.	156°12'W.	350	2	0.6	-	-	-	-	12	1 sunfish
3	10/5	40 mi. N. E. of Christmas I.		470	10 (1)	2.1	-	-	-	1	9	
4	10/6	40 mi. N. W. of Christmas I.		380	1	0.3	-	-	1	2	10	
5	10/8	15 mi. N. W. of Christmas I.		500	15 (6)	3.0	-	-	-	2	21	
6	10/9	15 mi. N. W. of Christmas I.		380	1	0.3	-	-	-	1	6	
7	10/10	2°07'N.	157°55'W.	460	9 (2)	2.0	-	-	-	-	9	
8	10/11	2°06'N.	157°25'W.	500	4 (2)	0.8	-	-	-	2	4	
9	10/13	0°50'N.	156°30'W.	500	7	1.4	-	-	-	-	17	
10	10/14	0°25'N.	157°43'W.	500	2	0.4	-	-	-	-	-	
11	10/15	1°56'N.	156°59'W.	500	1	0.2	-	-	-	-	9	
12	10/20	4°00'N.	157°15'W.	500	1	0.2	-	-	2	-	2	
Total				5,540	58 (12)	12.3	-	-	3	9	136	
Average					4.8 (1.0)	1.0	-	-	0.2	0.8	11.3	

[1/] Numbers in parentheses are shark-damaged fish and are included in the adjacent daily catch.

Table 15.--Summary of fishing locations and catches on steel and 11-hook cotton gear, Commonwealth cruise 2

Sta.	Date	Noon position		Estimated number of hooks	Total catch							
					Yellowfin		Number of fish					
		Latitude	Longitude		Number	Per 100 h.	Big-eye	Alba-core	Skip-jack	Marlin	Sharks	Miscellaneous
1*	10/28	1°10'N.	157°19'W.	600	1	0.2	1	-	1	1	14	
2*	10/29	2°14'N.	156°33'W.	600	20 (13)[1/]	3.3	-	-	-	1	17	
3*	10/30	2°30'N.	156°51'W.	300	7 (1)	2.3	-	-	-	-	14	
4	10/31	30mi. N.W. of Christmas I.		400	17 (6)	4.2	-	-	-	-	14	1 wahoo
5	11/1	30mi. N.W. of Christmas I.		480	18 (1)	3.8	-	-	-	-	7	
6	11/2	30mi. N.E. of Christmas I.		496	5	1.0	-	-	-	-	8	
7	11/3	30mi. S.E. of Christmas I.		480	11 (4)	2.3	-	-	-	1	-	
8*	11/4	1°42'N.	156°30'W.	550	12 (7)	2.2	-	-	-	1	14	
9	11/8	2°08'N.	157°49'W.	472	8 (2)	1.7	-	-	-	-	9	
10	11/12	30mi. N.W. of Fanning I.		544	19 (11)	3.5	-	-	-	1	31	
11	11/13	4°13.5'N.	159°15'W.	544	25 (3)	4.6	1	-	-	-	16	
12	11/14	3°33'N.	158°27'W.	540	5 (2)	0.9	-	-	-	2	3	
13	11/15	4°08.4'N.	159°44'W.	544	13 (8)	2.4	-	-	1	3	15	
14	11/16	30mi. N. E. of Fanning I.		400	14 (1)	3.5	-	-	-	-	10	
15	11/22	60mi. S.W. of Palmyra I.		520	3 (1)	0.6	-	-	-	-	19	2 barracuda
Total				7,470	178 (60)	36.5	2	-	2	10	191	
Average					11.9 (4.0)	2.4	0.1	-	0.1	0.7	13.6	

* Stations at which steel gear was fished.

[1/] Numbers in parentheses are shark-damaged fish and are included in the adjacent daily catch.

Table 16.--Yellowfin catch by hook number, North American cruise 1 (see fig. 20 - Appendix)

Sta.	Hook Number															Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
2	-	1	-	-	-	1	2	1	3	1	1	-	-	-	1	11
3	2	1	-	1	2	3	5	4	5	3	2	5	1	-	-	34
5	2	2	3	4	6	3	1	7	7	5	6	2	4	3	1	56
6	3	3	5	6	4	8	5	4	4	3	5	2	2	1	1	56
7	5	3	5	9	6	5	8	8	9	6	6	3	4	5	5	87
8	4	4	2	3	5	-	8	4	2	6	5	2	1	1	2	49
10	1	5	3	5	6	4	5	8	6	4	3	6	4	2	2	64
11	5	3	5	8	7	5	8	3	5	5	2	6	6	4	4	76
18	-	2	1	2	2	3	-	3	2	3	1	-	-	-	-	19
19	2	2	1	4	2	-	8	1	7	4	2	-	-	2	1	36
20	-	-	1	3	5	3	7	4	3	1	2	-	1	-	-	30
22	2	-	3	3	2	1	4	-	2	-	-	2	3	-	-	22
Total	26	26	29	48	47	36	61	47	55	41	35	28	26	18	17	540
%	4.8	4.8	5.4	8.9	8.7	6.7	11.3	8.7	10.2	7.6	6.5	5.2	4.8	3.3	3.1	100

Table 17.--Length frequencies of yellowfin taken on fabric gear on four cruises in the central Pacific (Line Islands), 1954

Fork length (cm.)	Male					Female				
	Manning 20	Gilbert 15*	N. Am. 2	N. Am. 1	Total	Manning 20	Gilbert 15*	N. Am. 2	N. Am. 1	Total
54-55	-	-	-	-	-	-	-	1	-	1
56-57	-	-	-	-	-	-	-	-	-	-
58-59	-	-	-	-	-	-	-	-	-	-
60-61	-	-	-	-	-	-	-	-	-	-
62-63	-	-	-	-	-	-	-	-	-	-
64-65	-	-	-	-	-	-	-	-	-	-
66-67	-	-	-	-	-	-	-	-	-	-
68-69	-	-	-	1	1	-	-	-	-	-
70-71	-	-	-	3	3	-	-	1	5	6
72-73	-	-	-	4	4	-	-	-	3	3
74-75	-	-	1	2	3	-	-	1	-	1
76-77	-	-	2	1	3	-	-	1	-	1
78-79	1	-	2	-	3	-	-	-	1	1
80-81	-	-	2	-	2	-	-	-	-	-
82-83	1	-	3	-	4	-	-	1	-	1
84-85	-	-	3	1	4	-	1	2	-	3
86-87	2	1	1	-	4	-	-	4	-	4
88-89	3	-	1	-	4	2	-	3	-	5
90-91	2	1	-	2	5	1	-	-	2	3
92-93	3	-	3	-	6	5	-	2	-	7
94-95	1	-	2	-	3	-	-	-	1	1
96-97	3	-	1	2	6	2	-	3	1	6
98-99	2	-	3	6	11	2	1	4	-	7
100-101	3	-	3	5	11	5	-	7	3	15
102-103	3	-	6	2	11	4	-	9	6	19
104-105	3	1	6	5	15	1	1	7	11	20
106-107	8	-	1	10	19	2	-	7	11	20

* Stations 54-75 only.

Table 17.--Length frequencies of yellowfin taken on fabric gear on four cruises in the central Pacific (Line Islands), 1954 (cont'd)

Fork length (cm.)	Male					Female				
	Manning 20	Gilbert 15	N. Am. 2	N. Am. 1	Total	Manning 20	Gilbert 15	N. Am. 2	N. Am. 1	Total
108-109	2	-	9	16	27	2	-	3	12	17
110-111	4	-	8	17	29	2	-	3	12	17
112-113	7	-	7	6	20	1	-	5	10	16
114-115	6	-	4	6	16	4	-	4	8	16
116-117	10	-	3	7	20	5	-	6	4	15
118-119	5	-	3	2	10	3	-	2	-	5
120-121	7	-	6	1	14	5	1	-	-	6
122-123	2	1	1	-	4	4	1	3	-	8
124-125	4	1	3	2	10	-	2	5	-	7
126-127	3	-	3	1	7	2	-	2	2	6
128-129	2	1	2	3	8	4	-	2	-	6
130-131	-	2	5	1	8	-	1	5	1	7
132-133	1	2	4	2	9	5	-	7	-	12
134-135	2	1	6	1	10	2	2	6	1	11
136-137	5	-	2	1	8	-	3	13	1	17
138-139	3	1	10	2	16	3	2	11	4	20
140-141	2	2	11	1	16	5	5	29	4	43
142-143	2	1	14	5	22	4	6	29	3	42
144-145	6	1	27	3	37	2	7	27	6	42
146-147	9	8	41	18	76	5	6	35	2	48
148-149	9	7	33	14	63	2	3	20	3	28
150-151	5	4	33	11	53	3	5	24	-	32
152-153	4	5	32	5	46	-	1	7	-	8
154-155	3	1	19	1	24	-	-	10	-	10
156-157	2	3	15	1	21	-	1	8	-	9
158-159	3	6	16	1	26	-	2	3	-	5
160-161	1	3	12	-	16	-	-	-	-	-
162-163	2	4	7	-	13	-	-	-	-	-
164-165	1	2	5	-	8	-	1	-	-	1
166-167	-	-	2	-	2	-	-	-	-	-
168-169	-	1	1	-	2	-	-	-	-	-
170-171	-	-	-	-	-	-	-	-	-	-
Total	147	60	384	172	763	87	52	322	117	578

Table 18. --Results of Japanese commercial longline fishing in the central Pacific during 1954 (data from Nomura 1954-55)

Area	Sta.	Boats	Baskets	Hooks	Average catch per 100 hooks										
					Yellow-fin	Big-eye	Alba-core	Skip-jack	Black marlin	White marlin	Striped marlin	Broad-bill	Sail-fish	Shark	Misc.
						JANUARY									
10°-11°N. 174°W.	17	1	6,120	24,480	0.41	4.04	0.06	-	0.19	-	0.01	0.04	-	-	-
29°-30°N. 179°-170°W.	20	1	5,868	29,340	0.01	1.42	2.34	0.06	-	-	0.04	0.11	-	0.18	-
30°-32°N. 170°-169°W.	18	1	6,230	31,150	-	1.63	0.72	0.31	-	-	0.05	0.12	-	-	0.02
						FEBRUARY									
10°-11°N. 176°-174°W.	18	1	6,480	32,400	0.34	3.10	0.12	-	0.25	0.02	0.01	0.01	-	-	0.02
23°-30°N. 171°-158°W.	28	1	8,720	43,600	0.08	1.14	0.03	0.01	0.10	0.02	0.08	0.11	-	0.03	-
						MARCH									
8°-12°N. 180°-165°W.	103	5	37,000	180,072	0.22	1.90	0.11	-	0.36	-	0.04	0.01	0.01	-	-
0°-11°N. 179°-166°W.	25	1	8,355	41,775	2.22	0.87	0.08	-	0.32	-	0.05	-	0.01	0.20	0.15
						APRIL									
8°-12°N. 179°-164°W.	243	12	89,528	421,344	0.13	2.39	0.06	0.04	0.43	0.01	0.05	0.02	0.02	-	0.10
0°-4°N. 178°-170°W.	85	4	32,335	140,857	3.07	0.50	0.21	0.03	0.40	0.03	0.02	0.01	-	-	-
2°N.-11°S. 177°-169°W.	34	1	13,490	53,960	3.93	0.72	0.57	0.10	0.37	0.05	0.01	0.02	0.01	-	0.02
						MAY									
9°-12°N. 170°W.-180°	27	2	9,805	49,025	0.07	2.57	0.01	0.02	0.78	0.01	-	0.02	-	-	-
5°S.-11°N. 169°-178°W.	20	1	7,200	36,000	1.99	1.43	0.28	0.09	0.43	0.04	0.03	0.01	-	-	-
3°N.-7°S. 155°-169°W.	29	1	12,319	43,704	6.54	0.40	0.59	-	0.38	0.08	0.02	0.02	-	-	-

Table 18.--Results of Japanese commercial longline fishing in the central Pacific during 1954 (data from Nomura 1954-55) (cont'd)

Area	Sta.	Boats	Baskets	Hooks	Average catch per 100 hooks										
					Yellow-fin	Big-eye	Alba-core	Skip-jack	Black marlin	White marlin	Striped marlin	Broad-bill	Sail-fish	Shark	Misc.
						JUNE									
0°-13°N. 157°-177°W.	113	4	45,108	180,096	0.36	2.63	0.01	0.05	0.72	0.01	0.05	0.01	0.02	0.69	0.33
2°N.-(3°S.) 170°-177°W.	49	1	20,050	80,200	3.72	0.21	0.43	0.05	0.22	0.04	0.01	0.01	-	0.18	-
1°-3°N. 157°-165°W.	36	1	14,400	64,800	2.20	0.93	0.19	-	0.40	0.02	-	0.19	-	-	-
						JULY									
6°-11°N. 179°-163°W.	46	1 (2)	17,451	71,253	0.38	2.01	-	-	0.83	-	-	0.01	-	-	0.01
1°-8°N. 179°-155°W.	136	6	52,100	232,345	3.99	0.54	0.11	0.05	0.35	0.03	-	0.01	0.03	0.05	0.03
0°-4°N. 166°-150°W.	66	2	24,360	121,800	5.80	0.26	0.22	0.02	0.21	0.03	0.03	-	-	-	0.16
1°-7°S. 178°-160°W.	57	2	22,620	100,740	2.78	0.58	0.11	0.22	0.37	0.02	0.01	0.02	0.05	0.26	0.04
						AUGUST									
6°-8°N. 136°-135°W.	25	1	10,223	51,115	2.45	2.63	-	-	0.30	0.05	0.03	0.01	-	-	0.02
6°-11°N. 174°-171°W.	18	1	6,660	26,640	0.57	1.55	-	-	1.31	0.01	-	-	-	-	0.38
0°-12°N. 180°-167°W.	37	1	14,275	57,100	2.43	0.91	0.12	-	0.65	0.03	0.01	-	0.01	0.20	0.03
2°S.-10°N. 162°-151°W.	34	1	13,764	53,950	1.87	1.75	0.01	-	0.99	0.02	-	0.01	-	0.64	0.01
						SEPTEMBER									
5°-11°N. 176°-172°W.	83	4	30,800	154,000	0.42	1.20	0.01	0.05	0.83	0.01	-	0.01	0.05	-	0.05
37°-39°N. 180°-177°W.	20	1	4,230	20,960	0.04	2.17	0.52	-	0.01	-	0.07	0.04	-	0.13	0.01
						OCTOBER									
4°-12°N. 178°-157°W	84	4	31,329	146,012	0.25	1.12	0.01	-	0.50	0.01	0.01	-	0.01	0.01	-

Table 18.--Results of Japanese commercial longline fishing in the central Pacific during 1954 (data from Nomura 1954-55) (cont'd)

Area	Sta.	Boats	Baskets	Hooks	Average catch per 100 hooks										
					Yellow-fin	Big-eye	Alba-core	Skip-jack	Black marlin	White marlin	Striped marlin	Broad-bill	Sail-fish	Shark	Misc.
					OCTOBER (cont'd)										
24°-32°N. 178°-168°W.	96	4	34,047	144,869	0.08	1.32	0.03	-	0.09	-	0.07	0.01	-	0.04	0.01
27°-39°N. 180°-167°W.	97	4	33,887	156,645	0.03	1.24	1.76	-	0.03	-	0.05	0.05	-	0.05	0.01
					NOVEMBER										
5°-9°N. 145°-133°W.	149	5	55,789	250,774	0.53	3.45	0.01	0.20	0.41	0.02	0.05	0.04	0.05	0.20	-
25°-32°N. 180°-163°W.	200	10	63,460	300,730	0.16	1.85	0.13	-	0.06	-	0.08	0.02	-	0.07	0.04
0°-16°S. 175°-176°W.	26	1	9,576	47,880	1.10	0.14	1.65	-	0.77	0.01	0.06	0.01	0.02	-	-
					DECEMBER										
5°-10°N. 142°-130°W.	99	3	37,924	163,166	0.96	3.73	-	0.06	0.24	0.01	0.10	0.03	0.05	0.12	0.02
7°-8°N. 148°-140°W.	14	1	5,695	23,480	0.22	2.95	-	-	0.51	0.01	-	0.04	0.04	-	-
28°-34°N. 180°-167°W.	203	9	65,592	316,753	-	1.95	0.91	-	0.01	-	0.06	0.12	-	0.25	0.02
25°-34°N. 170°-164°W.	134	6	43,075	195,455	0.11	2.11	0.15	-	0.03	-	0.04	0.03	-	0.11	0.01
4°-11°N. 175°-171°W.	14	1	4,692	23,460	0.43	1.37	-	-	0.14	0.01	0.02	-	0.01	-	-
19°-22°S. 174°-171°W.	19	1	6,485	32,425	1.07	0.09	6.00	0.04	0.79	0.02	0.43	0.02	0.02	-	0.30

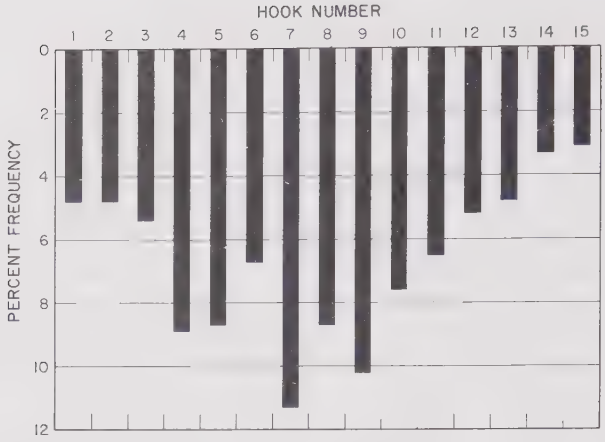

Figure 20.--Percentage of yellowfin catch by hook number (hence relative depth) on North American cruise 1, illustrating the prevalence of higher catch rates on the deeper hooks.

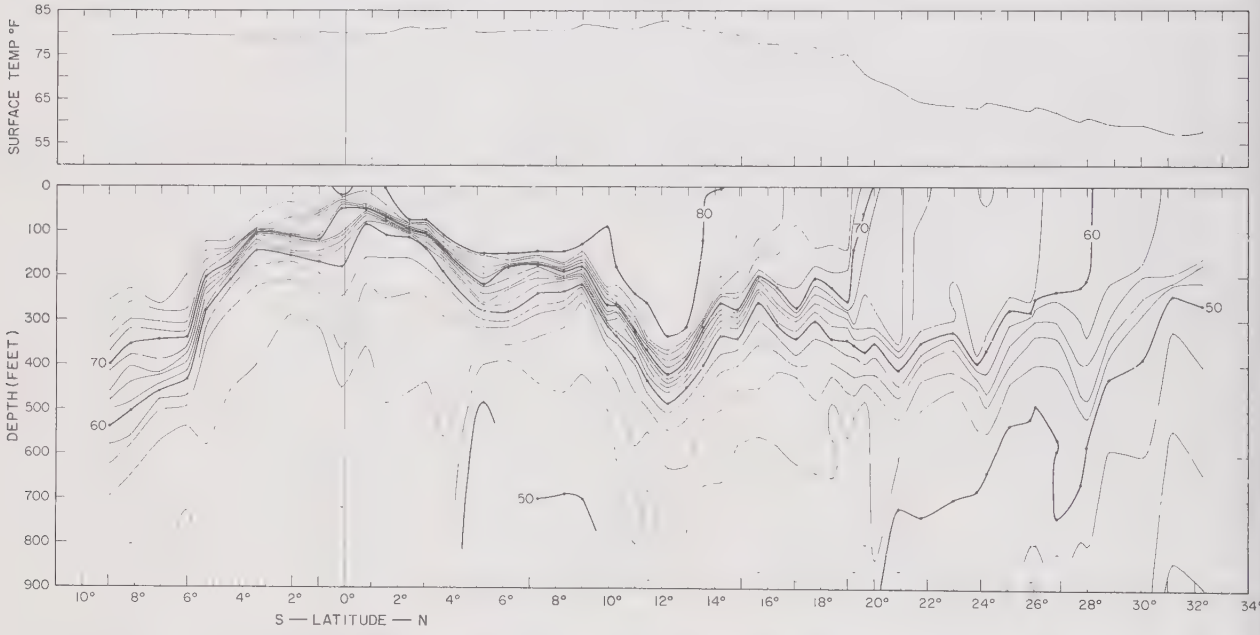

Figure 21.--Surface temperature and vertical temperature section along 120°W. and 109°W. longitude, February-March (Charles H. Gilbert cruise 15). Upper panel--surface temperatures as read at each bathythermograph lowering. Lower panel--temperature section based on bathythermograph lowerings; isotherms at 2°F. intervals, depth of lowering shown by horizontal dashes.

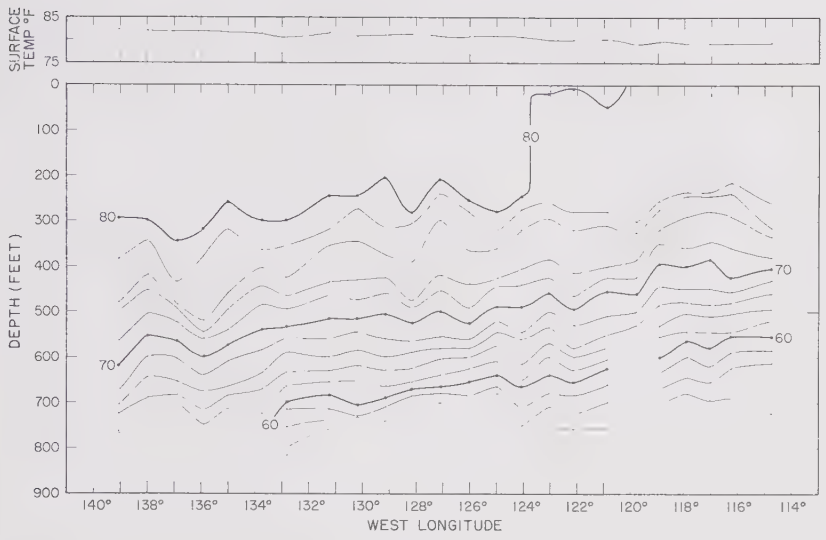

Figure 22.--Surface temperature and vertical temperature section along 9°S. latitude from 115°W. longitude to the Marquesas Islands, March (Charles H. Gilbert cruise 15). Upper panel--surface temperatures as read at each bathythermograph lowering. Lower panel--temperature section based on bathythermograph lowering; isotherms at 2°F. intervals, depth of lowering shown by horizontal dashes.

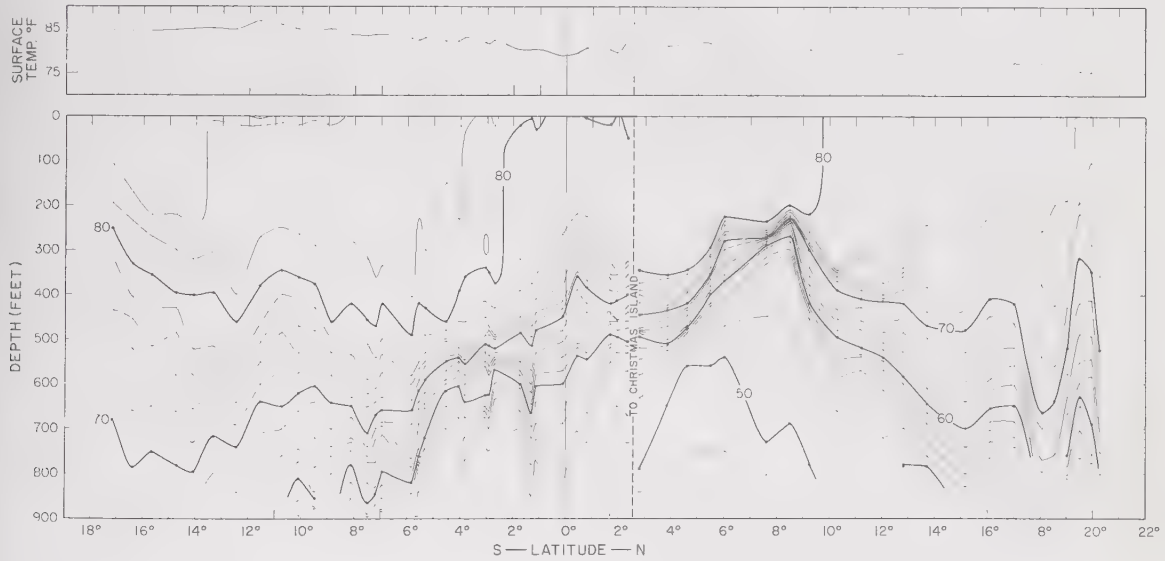

Figure 23.--Surface temperature and vertical temperature section along a south-north section between 149°W. and 157°W. longitude, April (Charles H. Gilbert cruise 15). Upper panel--surface temperatures as read at each bathythermograph lowering. Lower panel--temperature section based on bathythermograph lowering; isotherms at 2°F. intervals, depth of lowering shown by horizontal dashes.

COMPARATIVE STUDY OF FOOD OF BIGEYE AND YELLOWFIN TUNA IN THE CENTRAL PACIFIC

BY JOSEPH E. KING AND ISAAC I. IKEHARA

FISHERY BULLETIN 108
From Fishery Bulletin of the Fish and Wildlife Service
VOLUME 57

UNITED STATES DEPARTMENT OF THE INTERIOR, Fred A. Seaton, *Secretary*
FISH AND WILDLIFE SERVICE, John L. Farley, *Director*

ABSTRACT

Stomachs of 166 bigeye tuna (*Parathunnus sibi*) and 439 yellowfin tuna (*Neothunnus macropterus*), captured in the central Pacific by longline fishing, were analyzed quantitatively to determine whether there were differences in the food which might help explain differences in the horizontal and vertical distribution of the tunas. This study provides the first comprehensive report on the food of the bigeye tuna.

Representatives of 48 fish families and 11 invertebrate orders were found among the stomach contents of the yellowfin, as compared with 36 fish families and 9 invertebrate orders for the bigeye. Food items of major importance to both species were pomfret (*Collybus drachme*), snake mackerel (*Gempylus serpens*), and squid of the families Ommastrephidae and Loliginidae. Notable differences were the complete lack of stomatopods in the food of bigeye, whereas they were common in yellowfin, and the insignificance of juvenile tunas in the food of bigeye, as compared with their prominence in the food of yellowfin.

In both tunas, the smaller individuals consumed a greater proportion by volume of crustaceans and fish and a lesser proportion of mollusks than the larger size group. In both tunas there was a tendency for the volume of stomach contents to increase with depth of capture, but there was no marked variation in food composition over the range of depth sampled. In the bigeye the volume of stomach contents varied directly with the longline catch rate, while in the yellowfin there was little change in volume of stomach contents even with a marked change in catch rate.

Despite these differences, the foods of yellowfin and bigeye were remarkably similar. When occupying the same general area, the two species were found to have essentially the same feeding habits.

UNITED STATES DEPARTMENT OF THE INTERIOR, Fred A. Seaton, *Secretary*
FISH AND WILDLIFE SERVICE, John L. Farley, *Director*

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OMPARATIVE STUDY OF FOOD OF BIGEYE AND YELLOWFIN TUNA IN THE CENTRAL PACIFIC

By JOSEPH E. KING and ISAAC I. IKEHARA, *Fishery Research Biologists*

ne predominant species of tuna captured on line-fishing surveys of the Fish and Wildlife ice's Pacific Oceanic Fishery Investigations FI) are the yellowfin, *Neothunnus macropterus* mminck and Schlegel), and the bigeye, *Para- nus sibi* (Temminck and Schlegel), with a h ratio of about 5 to 1 in favor of the yellow- These are large tunas, the yellowfin oc- nally reaching a weight of 200 pounds and bigeye a weight of 300 pounds in the tropical fic. The two species have a marked super- l resemblance in general body shape and ration and are not always differentiated in commercial catch.

Murphy and Shomura (1953a, 1953b), in dis- ing results of experimental longline fishing ducted by POFI, point out interesting differ- s in the distribution of these two species. In tropical Pacific, the bigeye have been taken reatest numbers north of latitude 5° N. The catches of yellowfin, on the other hand, have made in the general region of the Equator, times to the north when the area is under influence of southeast tradewinds, and some- s to the south when the northeast trades are inant. This shift in abundance that appears related to changes in the prevailing winds now be explained, at least partially, from our ledge of the ocean currents and their effect he basic food supply (Cromwell 1953).[1] Al- gh the peaks in abundance do not correspond ly, the general area of high yellowfin catch lso the area of greatest zooplankton abund- e (King 1954). The horizontal distribution of bigeye, however, does not seem to conform to general pattern that the most fish are found re food is most abundant.

here is also some evidence of difference in the tical distribution of yellowfin and bigeye. ile the results are rather variable, there have been indications on certain POFI cruises to the equatorial area that the best catches of bigeye came from greater depths than those of the yellowfin (Murphy and Shomura 1953b). In Hawaiian waters the bigeye occurs in greatest numbers during the winter months from October to May, whereas the yellowfin is most abundant from May to September (Otsu 1954). Brock (1949) points out that the Hawaiian longline fishermen try to increase the catch of bigeye after the yellowfin season by lengthening the hook lines in order to fish deeper. Also, unlike the yellowfin, the bigeye—at least the adults—are rarely taken by surface-fishing methods. Nakamura (1949) states that the bigeye is thought to occur at the deepest levels of any of the tunas. It appears that the bigeye prefers somewhat colder water than does the yellowfin, or perhaps the two species have different feeding habits or food preferences which influence their distribution.

The purposes of this study are to describe the food of bigeye tuna in the central Pacific, to compare the foods of bigeye and yellowfin tuna[2] captured at about the same time and place, to determine whether differences occur which are associated with the horizontal and vertical distribution of these fish, and to obtain information on food preferences of each fish which may be useful to the commercial fishery. The experimental fishing carried out by POFI has provided collections of bigeye and yellowfin stomachs which are essentially alike in respect of time and area and which were obtained with standardized fishing methods. Therefore, we believe the resulting data should provide reliable comparisons of the food of these fish because these several variables have been controlled.

There is an extensive literature, reviewed previously by Reintjes and King (1953), dealing with the food of yellowfin, whereas there are only a very

lso a manuscript by O. E. Sette: Nourishment of central Pacific s of tuna by the equatorial current system (Proceedings of the 8th fic Science Congress).

[2] The food of yellowfin was previously described by Reintjes and King (1953).

few references pertaining specifically to the food of bigeye. Suyehiro (1942) describes this species as a very voracious fish and lists the following items as appearing in its food: amphipods, shrimp, cuttlefish, squid, sardines, sauries, bonitos, needle fish, and a viper fish. In the report of the South Seas Tuna Fishery Investigations for 1950 (Kanagawa et al. 1951), the food of 27 bigeye is shown to include the following: 7 squid, 1 octopod, 3 decapod Crustacea, 1 fan fish, 15 needle fish, 1 file fish, 6 pomfret, and 4 lantern fish. This suggests that the bigeye, like many other tunas, has a varied diet.

A large number of the tuna stomachs reported on here were examined by John W. Reintjes, Sueto Murai, and T. J. Roseberry, former employees of POFI. We appreciate their services in a difficult and generally disagreeable task. We are grateful to other staff members of POFI for assistance in handling these large fish aboard the vessels and in removing and preserving the stomachs.

SOURCE OF MATERIALS

This report is based on examination of 439 yellowfin and 166 bigeye stomachs collected on 11 cruises of Fish and Wildlife Service vessels d the years 1950 to 1953 (table 1). The yell data include 125 stomachs collected in 195 1951 and previously reported on by Reintje King (1953). These collections and the addi 314 yellowfin stomachs obtained in 1952 and were obtained at the same stations, or nea same stations, as furnished the bigeye sto included in this report. The sampling area (extended along the Equator between lat 119° W. and 180° and approximately fro itude 17° N. to latitude 14° S. at its greatest v

The tuna were captured by longline at d of about 150 to 500 feet. This method of fi as practiced by POFI, has been reviewe Murphy and Shomura (1953a); the desig construction of the gear was described by (1953).

Only fish caught 25 miles or more from lar considered in this study; therefore local diffe due to reef faunas should be reduced to a mum. The sampled fish varied widely in from 87 to 172 cm. fork length for the yell and from 77 to 196 cm. fork length for the b (fig. 2). Weights of fish given in this paper

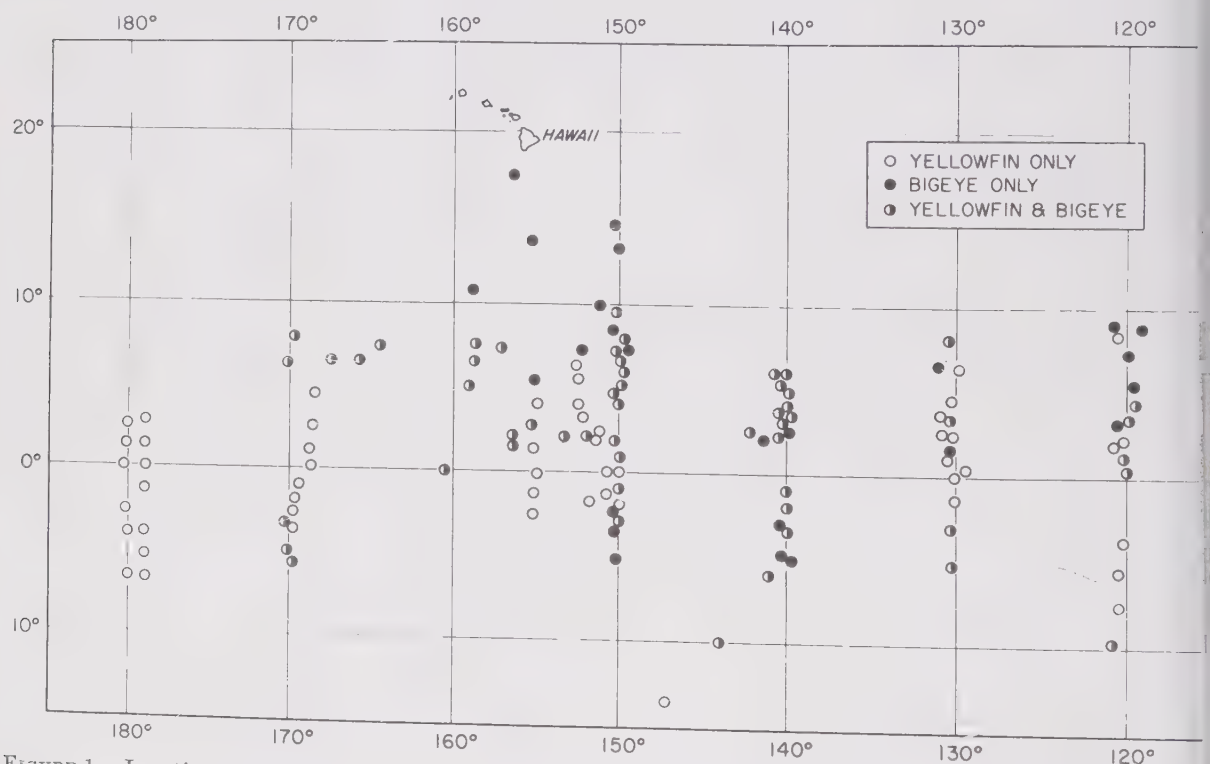
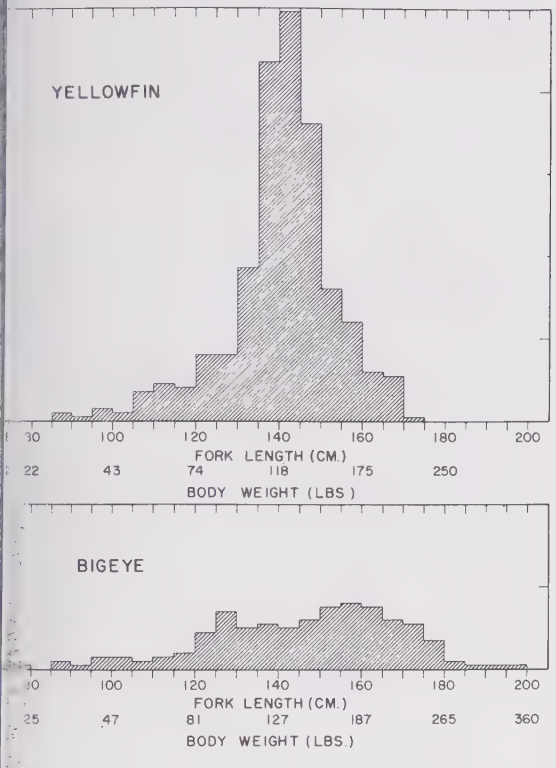


FIGURE 1.—Locations of the stomach collections of yellowfin and bigeye tuna captured by experimental longline fi in the central Pacific, 1950–53.

LE 1.—*Distribution of yellowfin and bigeye stomachs collected from the central Pacific, identified by vessel, cruise, time of year, and locality*

Vessel	Cruise No.—	Period	Sampling area		Yellowfin			Bigeye		
			Range of longitude (W.)	Range of latitude	Number captured	Number of stomachs examined	Percent of catch sampled	Number captured	Number of stomachs examined	Percent of catch sampled
. Smith	7	Oct.–Nov. 1950	157°–167°	11° N–0°	132	[1] 106	80	22	14	64
. Smith	11	Aug.–Sept. 1951	150°–156°	15° N–4° S	457	[2] 153	34	93	36	39
Manning	11	Jan.–Mar. 1952	155°–180°	5° N–7° S	210	59	28	30	6	20
H. Gilbert	1	May–June 1952	119°–130°	9° N–1° S	72	44	61	43	17	40
i	1	June–July 1952	140°	6° N–5° N	42	7	17	11	2	18
i	2	Aug.–Sept. 1952	140°–142°	6° N.–2° N	720	19	3	60	13	22
Manning	12	Aug.–Sept. 1952	140°–150°	7° N.–5° S	146	1	1	28	5	18
Manning	13	Oct.–Nov. 1952	151°–170°	17° N.–5° S	135	55	41	29	10	34
. Smith	18	Oct.–Nov. 1952	120°–131°	9° N.–10° S	60	40	67	50	17	34
Manning	14	Jan.–Mar. 1953	140°–150°	4° N.–14° S	106	69	65	19	19	100
Manning	15	Apr.–June 1953	150°–170°	10° N.–6° S	197	20	10	46	27	59

[1] this number, only 38 (29 percent of the catch) were considered comparable in respect to time and place to the bigeye collections and were included in
[2] this number, only 87 (19 percent of the catch) were included in this report for the same reason as above.



2.—Length-frequency distribution of yellowfin bigeye tuna from which stomachs were collected.

ed from length measurements converted by s of length-weight tables provided in the Scientific Field Manual (unpublished).

METHODS

sea, the stomach was removed as soon as ble after the fish was captured, placed with egurgitated material in an unbleached-muslin and preserved in 10-percent formalin. A label bearing date, species name, fork length, fishing method, hook number, bait used, name of observer, vessel, and cruise number was placed with each stomach. Tuna landed with their stomachs everted were not sampled.

The stomach was removed by one of the following methods: (1) The abdominal cavity was opened by a longitudinal midventral incision, the small intestine was severed posterior to the pyloric valve, and the stomach was freed by cutting through the esophagus; or (2) the gill membrane was slit along the line of attachment with the cleithrum posterior to the fourth gill arch, the viscera was pulled out, and the stomach was removed by cutting through the small intestine and esophagus.

In the laboratory, the stomachs were soaked in fresh water for a period of 16 to 24 hours to remove excess formalin. Each stomach was then slit open, and the contents were carefully removed and separated into groups according to kind of organism. Identifications were made as completely as was practicable, and the number of each species or group of organisms present was recorded. Each species or group was measured volumetrically by the displacement of water in a graduated cylinder of appropriate size. Bait used to capture the tuna was omitted from this analysis. The methods and literature used in the identification of the food organisms were essentially the same as that employed by Reintjes and King (1953) and will not be reviewed here. Berg's (1947) system of classification and nomenclature was primarily used for the family names of the forage fishes.

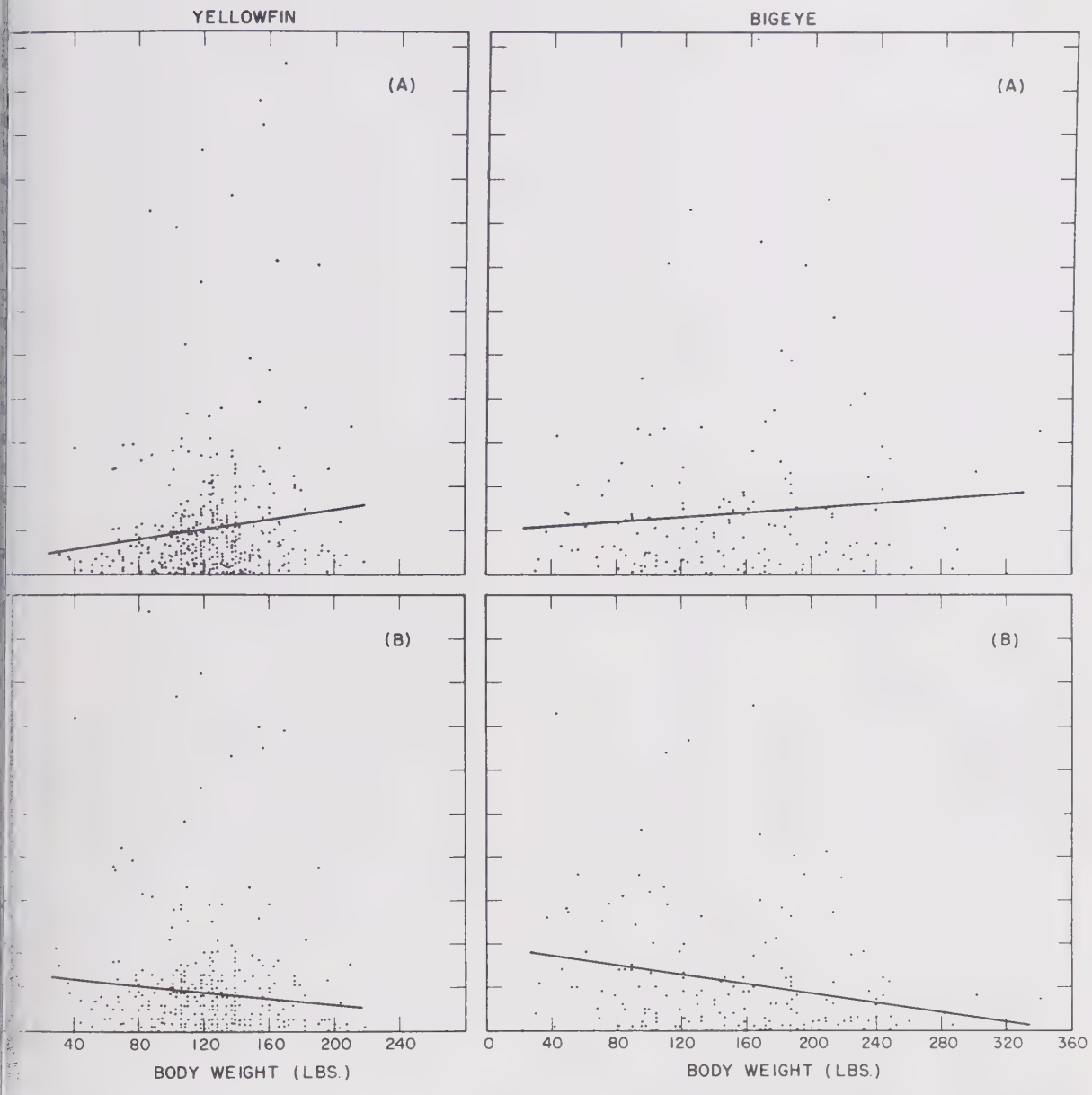
A detailed list of the food organisms found in the tuna stomachs is presented in the appendix (table 11). For each kind or group of organisms there are shown (1) the total number of such organisms, (2) the number of stomachs in which they occurred, (3) the percentage of occurrence, (4) the total aggregate volume of each food element, and (5) the percentage of total volume.

Regardless of the method or methods of analysis used, there are many uncontrollable variables inherent in food studies which detract from the precision of the results. It is our belief, however, that for a fish with a generalized diet, such as that of the tuna, any of the commonly used methods of evaluation will give substantially the same results if a sufficiently large number of specimens are examined. In reporting the results of our studies on tuna food we use both the percentage-of-occurrence and the percentage-of-volume measurements (as described by Reintjes and King 1953) and the average volume of food per stomach. The food items that rank high in nu volume, and frequency of occurrence are likely to be important foods.

No attempt has been made to apply stat tests of significance to the data. It is likel the variates used—volume of food per sto percentage of occurrence, and percentage o volume of the organism—are not distribute mally and that the means are correlated wi variances or standard deviations. To meaningful tests of significance, transforma the data would be necessary. Moreover, s of the comparisons that will be made i two-way or three-way classification of the Even if suitable transformations were d the application of advanced analysis of va techniques would be hampered by u subclass numbers.

Furthermore, it appears that in both ye and bigeye there is an increase in mean v of food per stomach with increase in size

FIGURE 3.—Examples of types of food commonly found in stomachs of yellowfin and bigeye tunas: Left to right fret (1), truncated sunfish (1), snake mackerel (1), lancet fish (1), shrimps (3), viper fish (3), hatchet fish (3), eup (8), juvenile stomatopods (3), crab megalopa (12), squid (3), and paper nautilus (1).



4.—Regressions of (A) food volume per stomach and (B) food volume per unit body weight on total body weight for 439 yellowfin and 166 bigeye captured on longlines.

there is also a decrease in average stomach nt per unit of body weight (cc./lb.) with ase in size of fish. The least-squares trend shown in figure 4 (there is no *a priori* reason ssuming rectilinearity) indicate the need for iance methods of statistical analysis, again suitable transformations. Finally we must out the great variability of the data as rated by the wide scatter of points about the lines. This great variability reduces the rtunity of demonstrating statistically significant differences, particularly when the data are analyzed in subgroups which contain few specimens in each.

Because of the difficulties outlined above, in the following sections we have tabulated average values and have discussed differences and trends without attempting to appraise their statistical significance. Consequently, the inferences that we make must be regarded as suggestions only. They may form the bases for hypotheses which can be tested more stringently in the future.

RESULTS

The food of both the yellowfin and the bigeye was primarily fish, of great variety, and squid (table 11, Appendix). Other mollusks, such as the argonauts and octopods, and crustaceans were of minor importance.[3] Figure 5 illustrates the percentage of occurrence of the major food items. Figure 6 shows the percentage of aggregate total volume of each major food element, which indicates its relative importance by bulk.

Representatives of 48 fish families and 11 invertebrate orders were found among the stomach contents of the yellowfin, as compared with 36 fish families and 9 invertebrate orders for the bigeye.[4] Despite this great variety in the food, only a few items were of primary importance to species. For both the yellowfin and the l those food elements ranking high in nu volume, and frequency of occurrence were sq the families Ommastrephidae and Loliginidi among the fish the pomfret (*Collybus drachm* snake mackerel (*Gempylus serpens*) were imp Certain fishes, such as the tunas (Thunnida the sun fishes (Molidae), were relatively imp in volume but ranked low in number and fre of occurrence, indicating that they are only sionally utilized. Crustacea of the order St poda, prominant in number in the food of y fin, were completely lacking from the stomachs. The young of other tunas, esp skipjack, formed a much more important p the yellowfin diet than that of the bigeye. following sections of this report we shall describe the major differences and similari the foods of these two species of tuna as rela such factors as size of the tuna, area and de capture, season, and features of the equa current system.

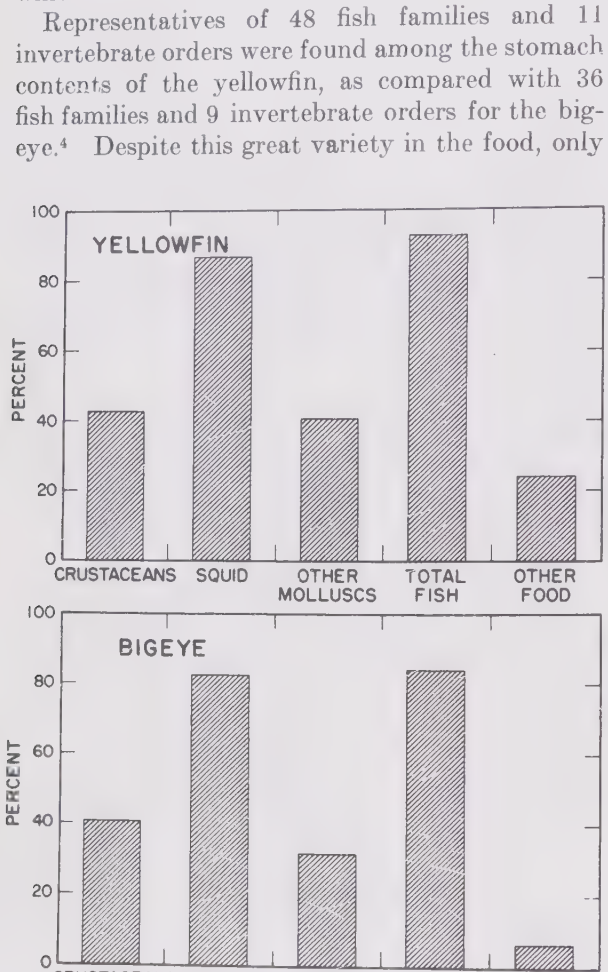


FIGURE 5.—Percentage of occurrence of the major food elements.

Variation in Food with Size of Tuna

In general, for both yellowfin and bigeye was an increase in food volume per stomac an increase in size of the tuna (fig. 4). Wi hope of minimizing the effects of this fac our examination of differences in the food ically related to size of tuna we have sp data for both species into two size grou those less than 140 cm.[5] and (2) those 140 c over, in fork length (table 2). This provid each species two groups of fish roughly eq number. In the yellowfin the larger size contained 29 percent more food per stomac in the bigeye it contained 16 percent more. ratios of stomach content to body weigh almost identical for the two species (tab Although Crustacea make up a very sma centage of the food of these large, deep-swi fish, in both species the smaller specimen sumed greater amounts of such organis crab larvae, shrimp, and amphipods. In species, the larger specimens consumed les and more mollusks—as percentage of volume—than did the smaller size group was particularly true for the bigeye. Th

[3] Among the results of this study, not referred to elsewhere in the report but perhaps worthy of mention, were observations on the number of stomach parasites. Among the bigeye, 26 percent of the stomachs examined were infested with nematodes and 32 percent with trematodes. The infestation was somewhat less among the yellowfin, being 16 percent for nematodes and 26 percent for trematodes.

[4] The greater variety in the food of the yellowfin as compared with the bigeye is due, we believe, simply to the fact that more than twice as many yellowfin stomachs were examined.

[5] A 140-cm. yellowfin from the equatorial Pacific weighs appro 118 pounds, while a 140-cm. bigeye weighs approximately 127 pound

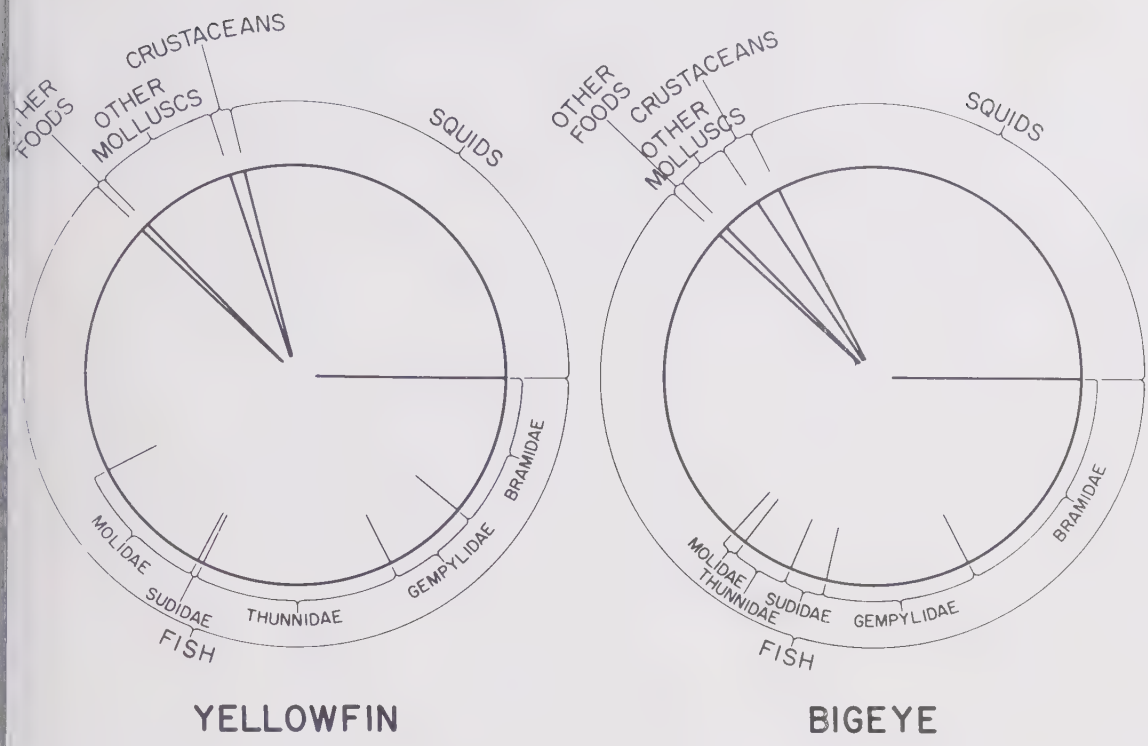
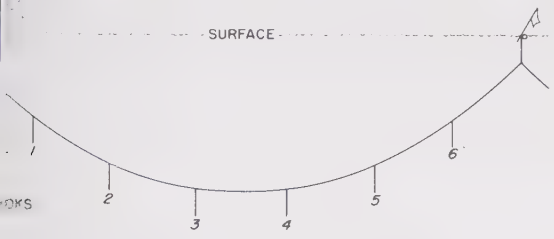


FIGURE 6.—Comparative importance, in volume, of the major food elements.

ge by occurrence and percentage by volume
fish families prominent in the diet exhibited
ariation with the size of the tuna.

Variation in Food with Depth of Capture

re 7 is a diagram of one unit (a basket) of
longline gear, showing the arrangement of
earing dropper lines and the general lay of
with respect to the surface. Although an
t is made to set the line at each station in a
rd fashion, with an average distance be-
buoys of about 900 feet, the actual depth
ng is quite variable depending upon the
t of sag in the main line, which is greatly
ced by wind and current conditions.



E 7.—Arrangement of a unit (basket) of POFI
dard longline gear showing the float lines, main line,
-bearing dropper lines, and the general lay of the
with respect to the surface.

8734 O—56——2

Murphy and Shomura (1953a) have calculated that the maximum possible depth for hooks 1 and 6, with a 900-foot buoy interval, is 310 feet; for hooks 2 and 5, it is 450 feet; and for hooks 3 and 4, it is 530 feet. These maximum depths are seldom achieved, however, because of the relatively strong surface currents generally prevailing in this region. The minimum depths are even more uncertain; therefore it is difficult to define a depth range for each of the hooks. We postulate that hooks 1 and 6 may fish at depths of 150 to 300 feet, hooks 2 and 5 at depths of 250 to 400 feet, and hooks 3 and 4 at depths of 300 to 500 feet. Despite this variation and the uncertainties involved, it is worthwhile, without attempting to designate actual fishing depths, to make comparisons between the shallow (hooks 1 and 6), intermediate (hooks 2 and 5), and deep (hooks 3 and 4) levels of capture with respect to differences in stomach contents. Because of the rather slight differences in composition of the food associated with the size of the tuna, the two size groups ($<$140 cm. and $>$140 cm.) were combined for this study.

Table 3 shows the variation in composition of stomach contents with depth of capture; the variation in the two general categories, squid and fish,

TABLE 2.—*Variation in volume and composition of stomach contents of yellowfin and bigeye tuna, by size groups*

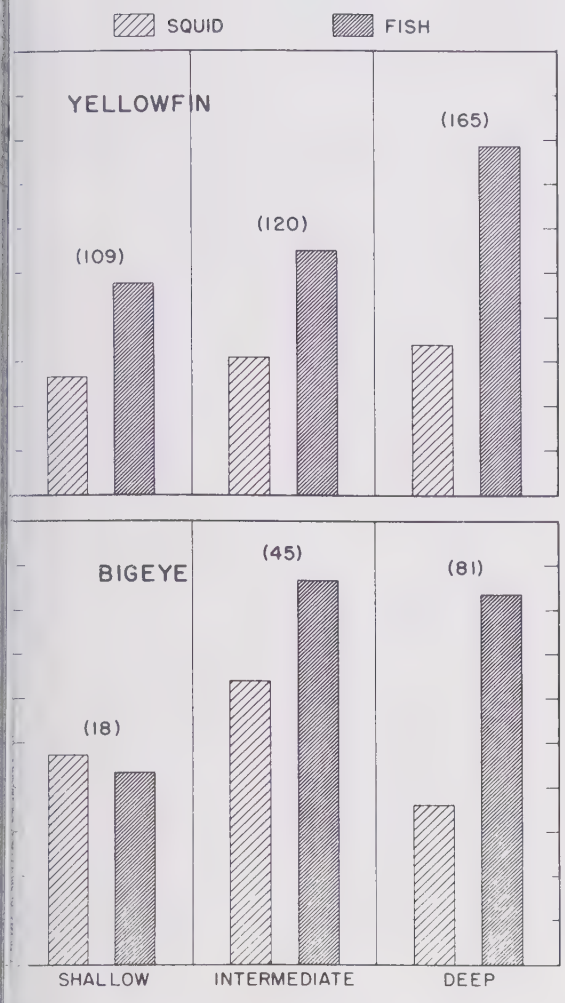
Food organisms	Average volume (cc.) per stomach in fish—		Percentage of occurrence in fish—		Percentage of total in fish—	
	Less than 140 cm., fork length	140 cm., and larger, fork length	Less than 140 cm., fork length	140 cm., and larger, fork length	Less than 140 cm., fork length	140 cm. and larger, fork length
Crustaceans:						
Yellowfin	1.5	0.9	45.2	41.0	1.7	
Bigeye	2.8	2.0	38.1	41.7	2.3	
Squids:						
Yellowfin	24.8	33.3	89.4	85.3	28.6	
Bigeye	32.1	51.4	81.0	83.5	26.2	
Other mollusks:						
Yellowfin	3.3	10.4	29.8	48.6	3.8	
Bigeye	1.6	5.7	28.6	34.0	1.3	
Fish (total):						
Yellowfin	56.6	67.7	90.4	94.8	65.2	
Bigeye	85.8	82.4	84.1	84.5	70.1	
Bramidae:						
Yellowfin	9.1	12.9	53.7	65.7	10.4	
Bigeye	33.3	17.3	36.5	31.1	27.2	
Gempylidae:						
Yellowfin	6.0	7.3	24.5	37.4	6.9	
Bigeye	19.2	12.5	42.9	34.0	15.7	
Thunnidae:						
Yellowfin	10.0	18.6	6.9	9.2	11.5	
Bigeye	0.3	8.6	1.6	3.9	0.3	
Sudidae:						
Yellowfin	0.4	0.5	9.0	5.2	0.5	
Bigeye	1.7	5.2	15.9	17.5	1.4	
Molidae:						
Yellowfin	13.4	7.2	3.7	2.0	15.4	
Bigeye	2.0	1.4	3.2	1.0	1.6	
Other foods:						
Yellowfin	0.6	0.6	23.9	24.3	0.7	
Bigeye	0.1	0.2	1.6	9.7	0.0	
All foods:						
Yellowfin	86.9	112.9				
Bigeye	122.4	141.6				
Number of stomachs examined:						
Yellowfin	188	251				
Bigeye	63	103				
Average fork length (cm.):						
Yellowfin	117	149				
Bigeye	122	160				
Average weight, lbs.:						
Yellowfin	69	142				
Bigeye	85	187				
Average volume (cc.) of food per lb. of body weight:						
Yellowfin	1.3	0.8				
Bigeye	1.4	0.8				

is illustrated in figure 8. For the yellowfin, there is an increase in average volume of stomach contents with increasing depth of capture; for the bigeye, the largest average volume was found at the intermediate depth, with the deep-caught fish ranking second. For both species, the most consistent feature was the low average food volume for the shallow-caught fish.

In the yellowfin, the increase with depth is largely due to a higher consumption of fish, particularly juvenile tunas (Thunnidae) and sunfishes (Molidae), at the intermediate and deep levels; the squid are utilized about equally at all three depths. In the bigeye taken on the deeper hooks, there is also greater utilization of fish, particularly pomfrets (Bramidae) and snake mackerels (Gempylidae), with squid decreasing in relative importance with depth but varying irregularly in absolute volume. Despite these rather minor differences, there is no marked variation in composition of stomach contents over this r of depth (estimated at 150 to 500 feet), which be evidence that both the forage organisms the tuna range throughout this water layer.

Variation in Food with Distance from Land

In the routine processing of the stomach the records were classified according to the dis of the place of capture from the nearest eme land. An arbitrary scale (0–24 miles, 25–99 100–399 miles, and 400 miles and more) was as in the previous study (Reintjes and King 1 No bigeye stomachs were collected at 0–24 r and few (eight) were collected in the 25–99 interval; therefore, the data do not provid desired information on differences in the related to this feature. There was some in tion that the consumption of squid and pom by the bigeye increased in an offshore dire as compared with their uniform utilization b



8.—Variation in the major food categories (total and squid) as related to the depth at which the tuna captured. Number of stomachs is shown in theses.

fin (table 4), and in the bigeye the average olume increased with greater distance from while in the yellowfin the volume varied larly.

Variation with Season and Longitude

examine differences related to time of sampl- the various cruises were grouped into four nal periods, as indicated in table 5. For species the largest average volume of food rred in the April–July period, with October- mber averaging the lowest in the yellowfin August-September the lowest in the bigeye. consider the average volume per stomach of major food elements, we find that, in our oles of both tunas, fish were consumed in greatest amount during April-July and in least amount during August-September (fig. 9 and table 5). The average volumes of squid and the major fish families represented in the food did not vary in parallel fashion for the bigeye and yellowfin.

When the data from the various cruises are combined with regard to longitude but without regard to time of year, we obtain the results presented in table 6, with the variation in availability

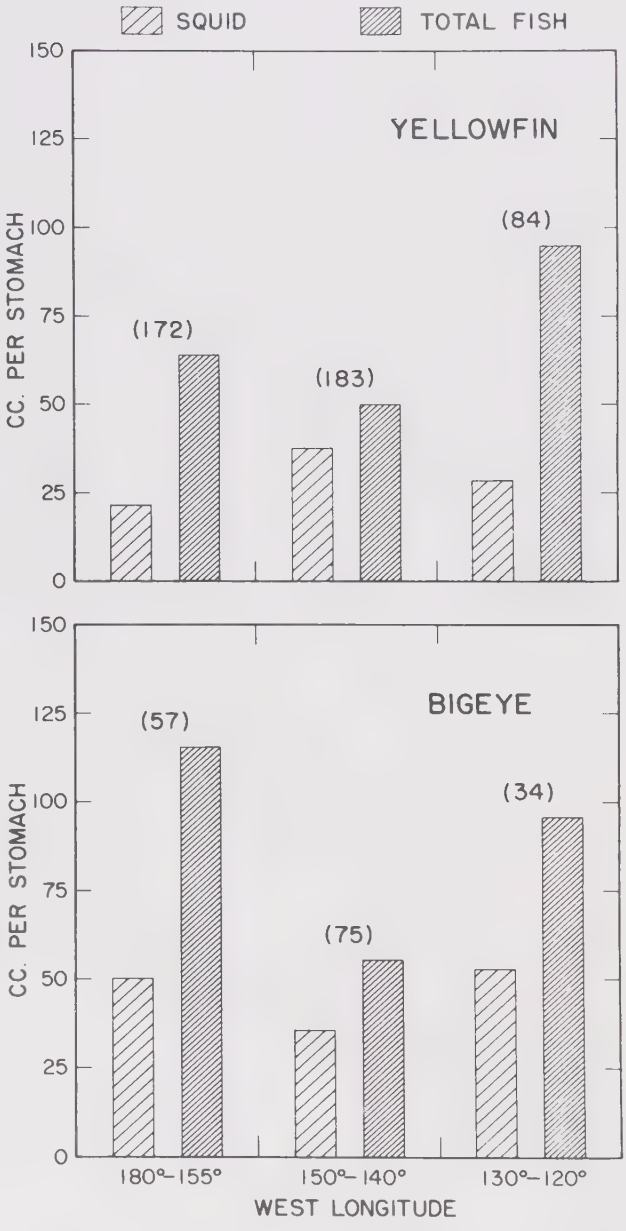


FIGURE 9.—Variation in the major foods as related to time of year that the tuna were captured. Number of stomachs is shown in parentheses.

TABLE 3.—*Variation in volume and composition of stomach contents with depth of capture of yellowfin and bigeye tu*

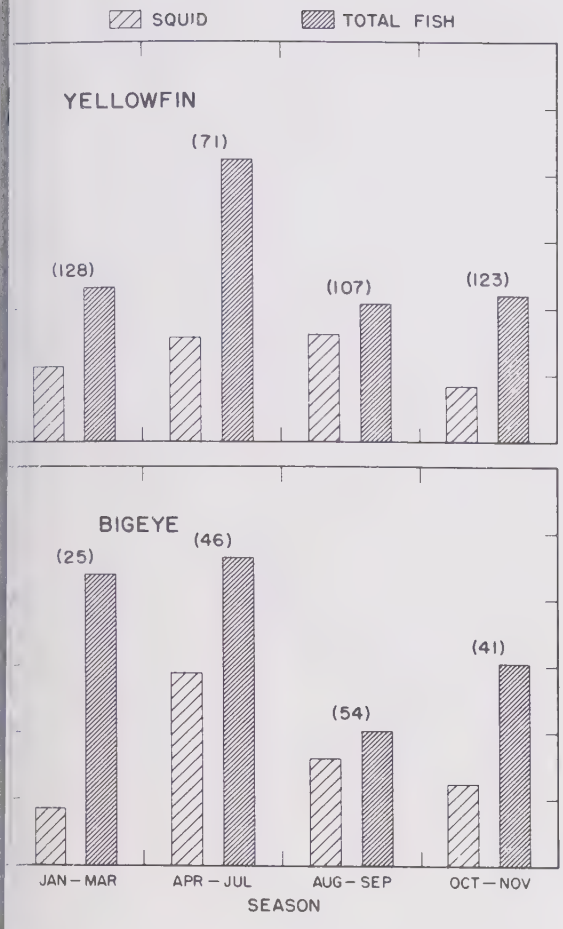
Food organisms	Average volume (cc.) per stomach			Percentage of occurrence			Percentage of total v	
	Shallow	Intermediate	Deep	Shallow	Intermediate	Deep	Shallow	Intermediate
Crustaceans:								
Yellowfin	1.8	0.7	1.1	39.4	44.2	46.7	2.0	0.8
Bigeye	0.7	1.4	3.2	33.3	35.6	46.9	0.7	0.9
Squids:								
Yellowfin	26.6	30.7	33.7	84.4	90.0	90.3	30.2	33.3
Bigeye	47.2	63.9	36.0	72.2	84.4	83.9	51.4	41.7
Other mollusks:								
Yellowfin	11.8	5.4	7.4	47.7	49.2	37.0	13.5	5.8
Bigeye	0.8	0.9	6.9	33.3	17.8	40.7	0.8	0.6
Fish (total):								
Yellowfin	47.4	54.9	78.6	91.7	91.7	93.9	53.8	59.5
Bigeye	43.2	86.7	83.7	72.2	86.7	85.2	47.0	56.5
Bramidae:								
Yellowfin	9.0	10.8	13.4	53.2	64.2	66.7	10.2	11.7
Bigeye	5.3	22.5	21.1	27.8	26.7	35.8	5.8	14.7
Gempylidae:								
Yellowfin	5.3	6.7	9.0	33.9	35.0	33.9	6.0	7.3
Bigeye	4.4	22.7	14.5	33.3	42.2	39.5	4.8	14.8
Thunnidae:								
Yellowfin	10.6	14.4	22.2	9.2	9.2	9.1	12.0	15.6
Bigeye	0.0	0.5	2.5	0.0	2.2	2.5	0.0	0.3
Sudidae:								
Yellowfin	1.0	0.4	0.3	11.9	4.2	7.3	1.2	0.4
Bigeye	5.0	6.0	3.5	11.1	17.8	22.2	5.5	3.9
Molidae:								
Yellowfin	1.8	4.4	12.8	1.8	1.7	2.4	2.0	4.8
Bigeye	0.0	3.4	1.4	0.0	4.4	1.2	0.0	2.2
Other foods:								
Yellowfin	0.5	0.4	0.9	27.5	23.3	27.3	0.5	0.5
Bigeye	0.0	0.3	0.1	5.5	8.8	7.4	0.0	0.2
All foods:								
Yellowfin	88.1	92.2	121.7					
Bigeye	91.9	153.3	129.9					
Number of stomachs examined:								
Yellowfin	109	120	165					
Bigeye	18	45	81					
Average fork length (cm.):								
Yellowfin	141	140	142					
Bigeye	152	148	142					
Average weight (lbs.):								
Yellowfin	120	118	122					
Bigeye	162	148	133					
Average volume (cc.) food per pound of body weight:								
Yellowfin	0.7	0.8	1.0					
Bigeye	0.6	1.0	1.0					

E 4.—*Variation in volume and composition of stomach contents with distance of place of capture from nearest emergent land*

Food organisms	Average volume (cc.) per stomach			Percentage by occurrence			Percentage of total volume		
	25–99 miles	100–399 miles	400 mi. and over	25–99 miles	100–399 miles	400 mi. and over	25–99 miles	100–399 miles	400 mi. and over
eans:									
owfin	1.2	1.8	0.4	53.3	52.7	7.7	1.1	2.2	0.4
eye	3.7	1.9	2.5	75.0	42.8	35.8	8.2	1.7	1.6
owfin	30.7	24.2	34.8	90.0	89.6	84.1	27.1	29.0	29.6
eye	9.8	17.9	64.2	75.0	76.2	87.4	21.7	15.4	41.8
ollusks:									
owfin	1.2	4.4	11.1	13.3	36.8	48.1	1.1	5.3	9.5
ye	3.0	2.2	5.5	25.0	34.9	30.5	6.6	1.9	3.6
tal):									
owfin	79.2	52.1	71.1	96.7	94.5	90.9	69.8	62.5	60.3
ye	28.0	94.0	81.5	62.5	85.7	85.3	62.0	80.9	53.0
idae:									
owfin	14.7	9.5	12.4	43.3	61.7	62.0	13.0	11.4	10.5
eye	1.5	15.0	30.7	25.0	25.4	38.9	3.4	12.9	20.0
ylidae:									
owfin	4.8	5.8	8.0	36.7	31.8	31.2	4.2	6.9	6.8
eye	21.9	18.5	12.2	12.5	38.1	38.9	48.5	15.9	7.9
idae:									
owfin	1.6	5.9	25.5	10.0	5.0	11.1	1.4	7.0	21.7
eye	0.0	10.8	2.4	0.0	3.2	3.2	0.0	9.3	1.5
dae:									
owfin	0.7	0.6	0.3	10.0	10.4	2.9	0.6	0.7	0.3
eye	3.7	5.1	3.1	12.5	17.5	16.8	8.2	4.4	2.0
ae:									
owfin	38.2	9.6	6.0	6.7	3.0	1.9	33.7	11.5	5.1
eye	0.0	4.2	0.0	0.0	4.8	0.0	0.0	3.6	0.0
oods:									
owfin	1.1	0.8	0.3	26.7	32.8	15.4	1.0	1.0	0.3
eye	0.7	0.2	0.1	12.5	6.3	6.3	1.5	0.1	0.0
ts									
owfin	113.4	83.9	117.9						
eye	45.1	116.2	153.8						
r of stomachs:									
owfin	30	201	208						
eye	8	63	95						
fork length (cm.):									
owfin	138	140	142						
eye	153	139	148						
weight (lbs.):									
owfin	112	118	123						
eye	166	125	149						
volume (cc.) food per pound of body weight:									
owfin	1.0	0.7	1.0						
eye	0.3	0.9	1.0						

TABLE 5.—*Variation in volume and composition of stomach contents with time of year at which the tunas were capt*

Food organisms	Average volume (cc.) per stomach				Percentage by occurrence				Percentage of total vo		
	Jan.–March	April–July	Aug.–Sept.	Oct.–Nov.	Jan.–March	April–July	Aug.–Sept.	Oct.–Nov.	Jan.–March	April–July	Aug.–Sept.
Crustaceans:											
Yellowfin	1.1	0.2	0.6	2.1	60.1	26.8	29.9	43.6	1.2	0.1	0.7
Bigeye	1.9	1.4	1.1	5.3	48.0	37.0	25.9	48.8	1.4	0.7	1.1
Squids:											
Yellowfin	27.0	34.4	40.3	21.1	94.5	76.0	96.3	91.0	28.8	22.2	41.2
Bigeye	21.8	72.4	40.3	30.9	80.0	78.3	85.1	92.7	16.0	37.3	40.9
Other mollusks:											
Yellowfin	7.9	14.5	4.5	5.4	46.9	47.9	39.3	21.0	8.4	9.3	4.7
Bigeye	3.2	3.9	5.6	2.9	48.0	30.4	13.0	26.8	2.3	2.0	5.6
Fish (total):											
Yellowfin	56.9	105.7	52.0	54.8	96.1	91.5	90.7	97.0	60.6	68.1	53.2
Bigeye	109.5	116.4	51.4	76.2	92.0	89.1	70.3	95.2	80.2	60.0	52.1
Bramidae:											
Yellowfin	8.0	14.9	14.1	10.8	60.1	50.7	69.2	60.9	8.5	9.6	14.4
Bigeye	29.1	51.8	4.5	12.8	24.0	43.5	33.3	31.7	21.3	26.7	4.6
Gempylidae:											
Yellowfin	8.1	8.0	1.9	8.6	45.3	23.9	24.3	28.6	8.7	5.2	2.0
Bigeye	11.5	16.9	8.0	24.3	48.0	37.0	28.0	39.0	8.4	8.7	8.1
Thunnidae:											
Yellowfin	10.4	25.7	25.1	5.2	7.8	16.9	5.6	5.3	11.1	16.6	25.7
Bigeye	-------	4.9	-------	16.6	-------	6.5	-------	4.9	-------	2.5	-------
Subidae:											
Yellowfin	0.9	0.2	0.0	0.5	13.3	7.0	0.9	5.3	1.0	0.1	0.0
Bigeye	13.0	2.6	2.2	1.8	36.0	19.6	5.6	12.2	9.5	1.3	2.2
Molidae:											
Yellowfin	0.0	32.9	0.2	14.7	0.0	12.6	0.9	2.3	0.0	21.2	0.2
Bigeye	-------	3.0	-------	3.0	-------	2.2	-------	4.9	-------	1.6	-------
Other foods:											
Yellowfin	0.9	0.3	0.3	0.8	43.7	9.9	7.5	25.6	0.9	0.2	0.3
Bigeye	0.2	0.03	0.2	0.1	12.0	6.5	3.7	9.8	0.2	0.02	0.2
All foods:											
Yellowfin	93.8	155.2	97.7	84.1							
Bigeye	136.6	194.1	98.7	115.3							
Number of stomach examined:											
Yellowfin	128	71	107	123							
Bigeye	25	46	54	41							
Average fork length (cm.):											
Yellowfin	140	141	140	141							
Bigeye	148	141	149	146							
Average weight (lbs.):											
Yellowfin	119	121	116	120							
Bigeye	148	129	151	142							
Average volume (cc.) food per pound of body weight:											
Yellowfin	0.8	1.3	0.8	0.7							
Bigeye	0.9	1.5	0.7	0.8							



e 10.—Variation in the major foods as related to the
ral longitude of capture of the tunas. Number of
achs is shown in parentheses.

major food items shown in figure 10. The
similarity between the two species lies in the
volume of total fish in the food of tunas
fed in the region of 140°–150° W. longitude.
tilization of squid, Bramidae, Gempylidae,
hunnidae does not vary in any regular
n for the two species. A majority of the
uidae appearing in the food of yellowfin
red in the area of 120°–130° W. were *Auxis*
rd, which was not prominent in the food in the
western regions and which in the bigeye was
sented by only one specimen, also from the
130° W. region.

r both bigeye and yellowfin, the largest
mens were captured in the eastern region
–130° W.) and the smallest in the western
n (155° W–180°). When the variation in
me of stomach contents is considered in terms
it volume per unit of body weight, we find
only slight regional differences for the yellowfin but a rather large variation for the bigeye (table 6). In the bigeye, specimens from the western region contained 1.5 cc. of food per pound of body weight, as compared with 0.6 cc. for specimens from the central region and 1.0 cc. for specimens from the eastern region. These three values closely parallel the corresponding average volumes of total fish per stomach (115.3, 55.4, and 95.8 cc.).

Variation with the Current System

The general pattern of the Pacific equatorial-current system has been described by Sverdrup and associates (1942, pp. 708–712). In brief, the major surface currents of this region are the North and South Equatorial Currents flowing toward the west, with the eastward-flowing Equatorial Countercurrent sandwiched in between. Although the width of the Countercurrent (CC) may vary with longitude and season, its southern and northern boundaries are ordinarily near latitudes 5° N. and 10° N. in the Central Pacific. The South Equatorial Current (SEC) is therefore on both sides of the Equator, while the North Equatorial Current (NEC) is confined entirely to the Northern Hemisphere.

The prevailing east to southeast tradewinds, together with the Coriolis force resulting from the earth's rotation, induce a divergence of the surface waters at the Equator that is accompanied by upwelling. Under certain conditions, described by Cromwell (1953) a convergence may be formed, between the Equator and the southern boundary of the CC, which, we hypothesize, may tend to concentrate plankton and, consequently, the tuna forage organisms.

Over the range of latitude sampled (17° N.–14° S.), there are therefore certain natural subdivisions of the environment that may be established on the basis of the features mentioned above. These may be defined as follows: (1) The NEC from the northern limit of our sampling (17° N.) to the northern boundary of the CC; (2) the CC, with its boundaries determined at the time of each crossing from vertical temperature sections;[6] (3) a zone of convergence in the SEC extending—according to our definition—from the southern boundary of the CC to latitude 1½° N.; (4) a zone of divergence or upwelling in the SEC along the Equator from latitude 1½° N. to latitude 1½° S.; and (5)

[6] Provided in the reports of Murphy and Shomura (1953a, 1953b, 1955).

TABLE 6.—*Variation in volume and composition of stomach contents with longitude of place of capture*

Food organisms	Average volume (cc.) per stomach			Percentage by occurrence			Percentage of total v	
	180°–155° W	150°–140° W	130°–120° W	180°–155° W	150°–140° W	130°–120° W	180°–155° W	150°–140° W
Crustaceans:								
Yellowfin	1.8	0.8	0.4	48.3	42.6	29.8	1.9	0.9
Bigeye	2.1	1.4	5.0	49.1	30.7	35.3	1.2	1.4
Squids:								
Yellowfin	21.6	37.7	28.8	90.7	96.7	78.5	23.3	40.0
Bigeye	50.1	35.5	52.9	82.4	84.0	88.2	29.4	36.5
Other mollusks:								
Yellowfin	4.6	5.3	17.5	26.2	46.4	40.5	5.0	5.7
Bigeye	2.7	4.9	4.5	33.3	24.0	20.6	1.6	5.1
Fish (total):								
Yellowfin	64.0	49.8	89.7	97.1	92.9	91.6	68.8	52.9
Bigeye	115.3	55.4	95.8	91.2	76.0	94.1	67.7	56.9
Bramidae:								
Yellowfin	10.5	12.1	11.9	56.4	72.7	45.2	11.4	12.9
Bigeye	48.3	6.0	19.8	36.8	30.7	38.2	28.3	6.2
Gempylidae:								
Yellowfin	6.3	3.8	14.3	27.3	38.2	26.2	6.7	4.0
Bigeye	16.5	9.4	24.8	31.6	34.7	47.0	9.7	9.6
Thunnidae:								
Yellowfin	7.3	15.4	29.4	7.0	4.4	17.8	7.8	16.4
Bigeye	12.3		5.9	7.0		2.9	7.2	
Sudidae:								
Yellowfin	0.7	0.2	0.6	9.3	6.6	2.4	0.7	0.2
Bigeye	3.8	5.1	1.1	24.6	12.0	8.8	2.2	5.2
Molidae:								
Yellowfin	19.1	0.1	11.9	6.4	0.5	1.2	20.6	0.1
Bigeye	4.6			5.3			2.7	
Other foods:								
Yellowfin	0.9	0.5	0.2	29.7	22.4	15.5	1.0	0.5
Bigeye	0.09	0.2	0.1	7.0	5.3	11.8	0.05	0.2
All foods:								
Yellowfin	92.9	94.1	136.6					
Bigeye	170.3	97.4	158.4					
Number of stomachs examined:								
Yellowfin	172	183	84					
Bigeye	57	75	34					
Average fork length (cm.):								
Yellowfin	136	141	147					
Bigeye	136	150	152					
Average weight (lbs.):								
Yellowfin	108	121	138					
Bigeye	116	155	160					
Average volume (cc.) food per pound of body weight:								
Yellowfin	0.9	0.8	1.0					
Bigeye	1.5	0.6	1.0					

the SEC from 1½° S. to the southern limit of our sampling (14° S.).

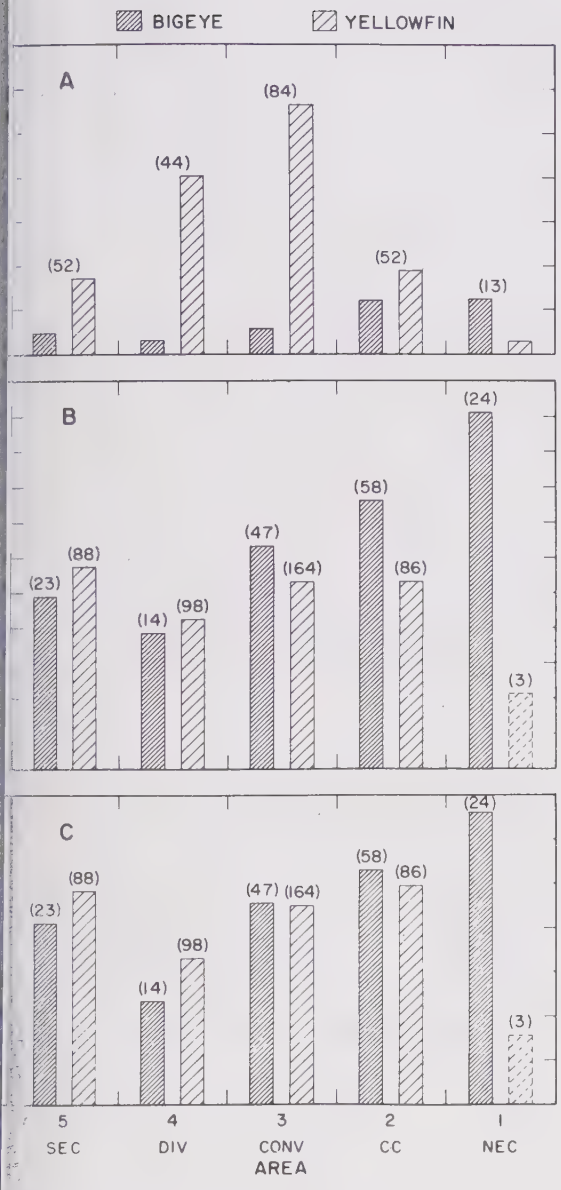
These areas have the following characteristics affecting the abundance of fish food: Area 1 is a region of low zooplankton concentrations (King and Demond 1953) and shallow thermocline. In area 2 the thermocline deepens to the south, and zooplankton shows some increase in abundance. Area 3 has a deep thermocline and a relatively high concentration of zooplankton. In area 4 at the Equator, upwelling is evidenced by a doming of the isotherms, a reduction in surface temperature, an increase in surface inorganic phosphate, and frequently by the greatest concentration of zooplankton. In area 5 the thermocline deepens, and the zooplankton concentration is reduced.

When the yellowfin and bigeye catch records [7] during the years 1950–53 are combined acco to these natural features of the environmen observe (fig. 11, A) that the area of best cat yellowfin was in the convergence zone (are while the best catches of bigeye came fron NEC (area 1) and the CC (area 2). Thu longline catch provides some indication c inverse relation in the abundance of these species.

The stomach-content volumes were com in the same manner—disregarding the r minor differences associated with depth of cap longitude, and season—to produce parts B a of figure 11.[8] For the yellowfin, we find nc respondence between catch per 100 hooks

[7] Summarized in reports of Murphy and Shomura (1953a, 1953b, 1955).

[8] Parts B and C of figure 11 are based on the 439 yellowfin stoma ployed in this report, which were considered comparable with th collections, and not on our total yellowfin-stomach data from the Pacific.



11.—Variations with the current system in (A) wfin and bigeye catch on longline gear, (B) average me of food per stomach, and (C) average volume of per pound of body weight. Boundaries for each di- n of the current system are defined in the text. Part derived from cruises 7, 11, and 18 of the *Hugh M. ith*, cruises 11, 12, 13, 14, and 15 of the *John R. Mann-* , cruise 1 of the *Charles H. Gilbert*, and cruise 1 of *Cavalieri*. Number of observations, as stations fished rt A) or stomachs examined (parts B and C), is wn in parentheses.

volume of stomach contents.[9] The divergence zone at the Equator produced good catches of yellowfin, but these fish contained the lowest food volumes. On the basis of both the average volume of food per stomach and the average volume of food per pound of body weight—disregarding the three stomachs collected from the NEC—we judge that the yellowfin captured in areas 2, 3, and 5 were equally well fed. In the bigeye, there is a suggestion of parallel variation in catch rate and volume of stomach contents. This species was the best fed in areas 1 and 2, which were also the areas of best catch. The bigeye from near the Equator (area 4), where catches were poorest, contained the lowest food volumes.

Table 7 illustrates variations in certain food components as related to the system of currents. The consumption of Crustacea by yellowfin is roughly in accordance with the varying abundance of zooplankton as determined from our plankton surveys (King and Demond 1953, King 1954). Their utilization by bigeye is quite different, however, and may be related to differences in the kinds of organisms involved. In the food of yellowfin, for example, the crustacean fraction was principally amphipods, with isopods and crab larvae of some importance; the bigeye had fed chiefly on shrimp and euphausids. The complex variations in the consumption of squid, Bramidae (chiefly *Collybus drachme*), Gempylidae (chiefly *Gempylus serpens*), and total fish are difficult to understand, since we lack information on the latitudinal variations in abundance of these forage organisms.

We should like next to examine in greater detail the differences between the CC (area 2) and the convergent zone (area 3) with respect to volume and composition of food utilized as related to depth of capture of the tunas. As previously stated, the CC is a region of relatively good catch for bigeye and of poor catch for yellowfin. Bigeye from this region contained about 50 percent more food in their stomachs than did the yellowfin, but they averaged somewhat larger in body size.

[9] It was previously reported (Reintjes and King 1953) that on one cruise (cruise 11, *Hugh M. Smith*) there was some indication that for yellowfin the average volume of stomach contents varied directly with the catch rate.

TABLE 7.—*Variations in average volume per stomach of the major food categories as related to the current syste*

[Boundaries of each area or division of current system are defined in text; volume is measured in cc.]

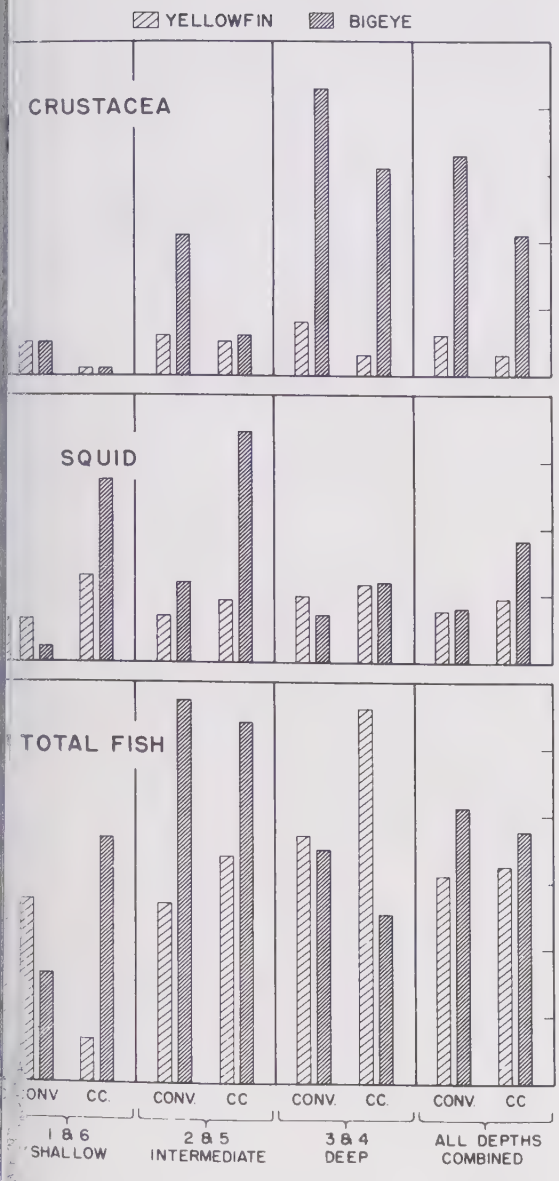
Food organisms	Area 1, NEC	Area 2, CC	Area 3, Conv.	Area 4, Div.	Area
Crustaceans:					
Yellowfin		0.3	0.6	2.9	
Bigeye	0.1	2.1	3.3	1.8	
Squids:					
Yellowfin	34.3	38.0	30.7	33.1	
Bigeye	38.9	73.1	32.3	29.2	
Other mollusks:					
Yellowfin		2.7	12.5	4.1	
Bigeye	7.1	1.3	8.1	0.7	
Fish (total):					
Yellowfin	8.0	64.9	62.2	44.0	
Bigeye	155.7	75.4	82.6	45.5	
Bramidae:					
Yellowfin	0.7	8.5	16.4	6.6	
Bigeye	5.0	41.0	22.5	0.5	
Gempylidae:					
Yellowfin	4.0	8.1	4.2	5.0	
Bigeye	37.2	6.9	18.1	11.7	
Thunnidae:					
Yellowfin		20.2	18.3	16.6	
Bigeye	28.3	3.5			
Sudidae:					
Yellowfin			0.2	0.1	
Bigeye	0.6	1.6	5.7	1.1	
Molidae:					
Yellowfin		2.5	1.2		
Bigeye	5.2				
Other foods:					
Yellowfin		0.2	5.7	0.7	
Bigeye			0.2	0.1	
All foods:					
Yellowfin	42.3	106.6	106.6	84.8	
Bigeye	201.9	152.0	126.4	77.3	
Number of stomachs examined:					
Yellowfin	3	86	164	98	
Bigeye	24	58	47	14	
Average fork length (cm.):					
Yellowfin	147	136	141	144	
Bigeye	149	146	145	153	
Average weight (lbs.):					
Yellowfin	138	108	119	129	
Bigeye	153	143	139	164	
Average volume (cc) food per pound of body weight:					
Yellowfin	0.3	1.0	0.9	0.7	
Bigeye	1.3	1.1	0.9	0.5	

On the basis of average volume of food per pound of body weight there was little difference between the two species.

The region of convergence has yielded the best yellowfin catches but has produced consistently poor bigeye catches. In this region the bigeye had about 20 percent more food in their stomachs than did the yellowfin, but the bigeye were also larger in average body size. Again the two species were almost identical with respect to average volume of food per pound of body weight.

In the CC, the thermocline occurs at shallow to moderate depths, while in the convergent zone it lies much deeper. Accompanying changes in the depth and velocity of the surface currents may greatly affect the fishing depth of the longline. In the region of shallow thermocline it is possible that, as a result of the streaming of the line caused by the marked shear between the moving surface waters and the relatively quiet waters below the thermocline, all hooks may be fishing at about the same level (Murphy and Shomura 1953b), a marked difference might be expected in the between the various hook levels. In a regi deep thermocline the longline can hang vert and lie entirely within the homogenous su layer. A marked difference in hook depth possible differences in the stomach contents catch may then result.

Data have been assembled in table 8 and 12 to illustrate the variations in average vo per stomach for the major food categories depth of capture of the tunas in these two areas. In the CC there is greater change i food of yellowfin with depth than in the conve zone; this is evidenced by a consistent increas depth, in the CC, in the utilization of Bram Gempylidae, and total fish. In the bigey only important and consistent variation sho the CC is a marked increase with depth i amount of Crustacea eaten and a decrease i importance of Gempylidae, as contrasted



12.—Variations in average volume per stomach major food categories with depth of capture of 250 wfin and 105 bigeye tuna taken by longline in the tercurrent and the convergent zone.

crease with depth in Gempylidae as noted ellowfin. In the convergent zone there is a ar increase with depth in the utilization of acea and Bramidae.

e major foods are of about equal importance oth areas. There is no indication that the s have one set of foods in the CC and another ne convergent zone. The main difference een the two species is the much greater consumption of Crustacea by the bigeye in both the CC and the convergent zone. If we may consider the longline catch rate as an index to abundance, it would appear that the bigeye responds in a different manner than the yellowfin to the more favorable foraging conditions which, we hypothesize, exist in the convergent zone.

OTHER VARIATIONS IN VOLUME OF STOMACH CONTENTS

When the stomach-content volumes are classified according to an arbitrary scale, the results (table 9) indicate for both species a rather low percentage of empty or near-empty stomachs; the average stomach contained a relatively small amount of food. This may mean that feeding is almost continuous, as contrasted with an irregular or spasmodic feeding habit, and that these fish have a high rate of digestion. For instance, it is hard to believe that a food volume of less than 100 cc., which was found in more than 50 percent of the stomachs (table 9), constitutes a daily or even semidaily ration for these large active fish. Unfortunately, our food studies provide no information on rate of food consumption or digestion.

In longline fishing, the gear is ordinarily set at daybreak and is hauled in during the afternoon. The time of landing is known, but not the time that the fish took the hook. On some cruises, 50 percent or more of the tuna are dead when landed. One might assume that these fish had been on the line for a longer period of time than the fish that were landed alive. On the basis of this hypothesis we examined the records from certain cruises for which we had the greatest number of observations supplying information on condition when landed. These data, as summarized in table 10, seem to indicate that the fish that were dead when landed contained larger volumes of food, on the average, than those that were landed alive. Although we cannot satisfactorily explain this difference, we believe that it may be related to the tendency for more dead fish to occur on the deep hooks than on the hooks fishing at shallow and intermediate depths; and in the yellowfin, at least, we have found an increase in volume of stomach contents with depth of capture (table 3). A combination of these factors might produce the results shown in table 10.

TABLE 8.—*Variations in average volume of food per stomach in pelation to depth of capture, comparing yellowfin and bigeye tuna taken by longline in the Countercurrent and convergent zone*

[Organisms making up less than 1 percent of the total food volume for each depth category were omitted from table; volume is measured in cc.]

Food organisms	Convergent zone						Countercurrent				
	Yellowfin			Bigeye			Yellowfin			Bigeye	
	Hooks 1 and 6 (shallow)	Hooks 2 and 5 (intermediate)	Hooks 3 and 4 (deep)	Hooks 1 and 6 (shallow)	Hooks 2 and 5 (intermediate)	Hooks 3 and 4 (deep)	Hooks 1 and 6 (shallow)	Hooks 2 and 5 (intermediate)	Hooks 3 and 4 (deep)	Hooks 1 and 6 (shallow)	Hooks 2 and 5 (intermediate)
Crustacea (total)	0.5	0.6	0.8	0.5	2.1	4.3	0.1	0.5	0.3	0.1	0.6
Penaeidae						4.2					
Squids (total)	25.5	27.6	39.4	9.2	47.7	28.4	52.1	37.4	46.5	110.0	138.5
Loliginidae:											
Loligo sp.						1.7					
Sepioteuthis sp.			1.8			2.9	12.3		2.8	43.0	4.9
Unidentified Loliginidae	3.1		4.6		20.1	3.7		8.2	18.0	39.6	11.0
Onycoteuthidae					5.2						
Enoploteuthidae:											
Abralia sp.						1.2					
Unidentified Enoploteuthidae						3.3	2.1	1.8	1.9	7.1	
Ommastrephidae:											
Ommastrephes sp.									3.4		
Notodarus sp.											
Unidentified Ommastrephidae	7.3	4.6	2.1	5.1	5.0	8.8	5.0	7.3	3.6	8.1	103.1
Sepiolidae		2.0						2.9	3.4		17.6
Cranchiidae:											
Liocranchia globulus								1.4	2.9		
Unidentified Cranchiidae											
Other mollusks (total)	14.3	8.4	15.4		0.9	12.3	1.4	3.3	2.6		1.5
Octopodidae	2.0	2.3	10.6			7.5		1.5			
Argonautidae:											
Argonauta sp.			2.1			1.9					
A. bottgeri	1.6	1.0				2.5					
Unidentified Argonautidae	10.3	3.5	1.2				0.9	1.6			
Fish (total)	54.7	53.8	74.2	32.5	114.6	70.0	12.9	68.0	111.9	73.3	107.9
Gonostomidae: *Vinciguerria lucetia*						1.2					
Sternoptychidae:											
Sternoptyx diaphana	9.7					2.7					
Unidentified Sternoptychidae				0.6		0.6				3.6	
Sudidae:											
Paralepis sp.					9.0	1.8					
Unidentified Sudidae				26.3		0.5					
Alepisauridae: *Alepisaurus* sp.											
Exocoetidae:											
Cyselurus sp.		1.7									
Unidentified Exocoetidae		0.1						3.4			
Trachypteridae: *Trachypterus* sp.						1.4					
Caulolepidae									3.6		
Atherinidae: *Atherinus insularum*						2.0					
Priacanthidae: *Priacanthus cruentatus*							1.2				
Carangidae:											
Seriola sp.	1.8										
Naucrates sp.	2.4										
Scomberoides sp.		2.4									
Bramidae:											
Collybus drachme	10.1	15.3	8.5	3.5		9.9		4.0	12.4		61.7
Taractes sp.	1.4	1.1	4.6		8.2	14.9			4.1		4.5
Unidentified Bramidae	2.6	1.0	0.4		1.3	7.7	4.6	3.5	0.6		1.4
Chiasmodontidae											
Gempylidae:											
Gempylus serpens	2.0	1.3	5.2		39.0	4.2	1.2	4.3	15.5	9.5	9.5
Unidentified Gempylidae	1.2	1.7	1.3	0.6		0.4		1.0	3.2	9.5	0.4
Nomeidae:											
Nomeus sp.						2.3					
Unidentified Nomeidae						0.1	0.8				
Thunnidae:											
Katsuwonus pelamis	8.1	4.4	12.8					28.2	41.1		
Neothunnus macropterus			15.8								
Auxis thazard		6.4	4.2								
Unidentified Thunnidae			1.1					0.3			
Echeneidae:											
Echeneis sp.	1.4										
Remora remora							0.9	3.8			
Unidentified Echeneidae	0.2						0.3	0.8			
Balistidae:											
Balistes nycteris	1.2	4.3									
Unidentified Balistidae	0.2	0.8									
Ostraciidae:											
Ostracion diaphanus			1.9								
Lactoria schlemmeri						2.3					
Unidentified Ostraciidae			3.3				0.7				
Tetrodontidae: *Tetrodon* sp.								6.8	1.7		
Molidae: *Ranzania* sp.		1.3							0.6		
Other foods	4.0								161.9	183.4	248.6
All foods	0.5	0.4	0.8		0.7						
	95.6	90.8	130.4	42.2	166.0	115.3	66.5	109.5			
Number of stomachs examined	49	49	61	3	14	28	9	25	25	7	13
Average fork length (cm.)	141	141	141	146	153	141	131	135	139	153	146
Average weight (lbs.)	120	120	120	139	164	130	97	106	115	162	144
Average volume of food per pound of body weight (cc.)	0.8	0.8	1.1	0.3	1.0	0.9	0.7	1.0	1.4	1.1	1.7

9.—*Distribution of the volume of stomach contents of 439 yellowfin and 166 bigeye caught by longline fishing in the central Pacific*

Volume (cc.)	Less than 140 cm. long			140 cm. or larger		
	Number	Percent of total number	Accumulated percentage	Number	Percent of total number	Accumulated percentage
owfin	6	3.2	3.2	4	1.6	1.6
ye	2	3.2	3.2	6	5.8	5.8
owfin	17	9.0	12.2	17	6.7	8.3
ye	4	6.3	9.5	10	9.7	15.5
owfin	21	11.2	23.4	22	8.7	17.0
ye	9	14.3	23.8	9	9.4	24.9
owfin	45	24.0	47.4	50	19.9	36.9
ye	10	15.8	39.6	13	12.6	37.5
owfin	49	26.1	73.5	66	26.2	63.1
ye	11	17.5	57.1	18	17.5	55.0
9:						
owfin	31	16.5	90.0	56	22.2	85.3
ye	13	20.6	77.7	24	23.3	78.3
9:						
owfin	15	8.0	98.0	30	11.9	97.2
ye	12	19.0	96.7	17	16.5	94.8
9:						
owfin	4	2.1	100.0	3	1.2	98.4
ye	2	3.2	100.0	5	4.9	99.7
id over:						
owfin	0	0.0		3	1.2	100.0
ye	0	0.0		1	1.0	100.0
owfin	188			251		
ye	63			103		

10.—*Summary of data relating average volume of stomach contents to condition of fish, whether dead or alive, at time of landing*

Cruise	Yellowfin			Bigeye		
	Average volume of stomach contents	Number of stomachs examined	Average fork length	Average volume of stomach contents	Number of stomachs examined	Average fork length
Smith cruise 11:	*cc.*		*cm.*	*cc.*		*cm.*
ed dead	93.7	64	135	174.9	11	152
ed alive	50.6	23	141	83.5	24	148
Manning cruise 14:						
d dead	95.6	37	143			
ed alive	71.4	32	144			
Manning cruise 15:						
ed dead				100.9	9	119
d alive				280.5	10	137

SUMMARY AND CONCLUSIONS

This study is based on the quantitative sis of the stomach contents of 166 bigeye (*Parathunnus sibi*) and of 439 yellowfin tuna thunnus *macropterus*) caught at the same or nearly the same time as the bigeye.

These tuna were captured in the central fic during the period October 1950–June 1953 neans of longline-gear fishing at depths of to 500 feet.

The food of the yellowfin consisted of fish percent by volume), squid (29 percent), other usks (7 percent), and crustaceans (1 percent); the food of bigeye consisted of fish (62 percent), squid (33 percent), other mollusks (3 percent), and crustaceans (2 percent).

4. Both species of tuna appear to utilize a great variety of animal food, ranging from small plankton organisms to large squid and fish. Food items of major importance to both species were pomfret (*Collybus drachme*), snake mackerel (*Gempylus serpens*), and squid of the families Ommastrephidae and Loliginidae.

5. This great diversity of diet suggests that many forms of fish, squid, and shrimp—if available through culture or capture—might be effective as live bait or longline bait in tuna fishing.

6. Stomatopod crustaceans, common in the food of yellowfin, were completely lacking from the bigeye stomachs. The young of other tunas, mostly skipjack, formed a much more important part of the yellowfin diet than of the bigeye diet.

7. In both species, the larger tuna had more food in their stomachs than did the smaller fish, but the larger fish contained less food per pound of body weight than did the smaller fish. There were few completely empty stomachs.

8. In both tunas, the smaller individuals consumed a greater proportion by volume of crustaceans and fish and a lesser proportion of mollusks than the larger size group. The same fish families were prominent in the diet of both size groups.

9. There was an increase in volume of stomach contents with depth of capture for the yellowfin; in the bigeye, the largest volumes were found in specimens from intermediate depths. There was no marked variation in composition of stomach contents over the range of depth sampled (estimated at 150 to 500 feet), which may be evidence that both the forage organisms and the tuna range rather freely throughout this water layer.

10. In both yellowfin and bigeye, fish were consumed in greatest amount during the period April–July, and in least amount during August and September. There was little correspondence between the two species in the seasonal variation in the other major food items.

11. In respect to longitudinal variations in the food, the two species were similar in the lower volume of total fish in the stomach contents of those tunas captured in the central region (140°–150° W. longitude) of the sampled area. The utilization of specific foods did not vary with longitude in any regular pattern for the two species.

12. When classified according to natural subdivisions of the equatorial current system, the volume of stomach contents in the bigeye varied directly with the longline catch rate, while in the yellowfin there was little change in volume of stomach contents with even a marked change in catch rate.

13. Tuna that were dead when landed contained, on the average, more food in their stomachs than those landed alive.

14. Despite the differences that we have pointed out, the foods of the yellowfin and bigeye are remarkably similar. We conclude, therefore, that when occupying the same general area the species have essentially the same feeding h If there is any marked food selection, it mu exercised by seeking different areas for fee

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APPENDIX

TABLE 11.—*Check-list of food organisms found in the stomachs of 439 yellowfin and 166 bigeye tuna captured on long the Central Pacific, 1950–53*

[Family names of fishes are as given in Berg 1947]

Food organisms	Yellowfin					Bigeye				
	Number of organisms	Stomachs in which occurred		Aggregate total volume		Number of organisms	Stomachs in which occurred		Aggregate volun	
		Number	Percent	Cubic centimeters	Percent[1]		Number	Percent	Cubic centimeters	P
CTENOPHORA						1	1	0.6	0.1	
ARTHROPODA										
Crustacea	[1,761]	[188]	[42.8]	[496.1]	[1.1]	[669]	[67]	[40.4]	[388.0]	
Mysidacea:										
Mysidae:										
Mysis sp.	8	1	0.2	6.3						
Unidentified mysids	52	2	0.5	4.9						
Isopoda:										
Idotheidae	175	44	10.0	34.4		103	12	7.2	3.7	
Cymotheidae	27	2	0.5	1.5		2	1	0.6	0.4	
Tanaidae	1	1	0.2	0.1						
Unidentified isopods	54	12	2.7	11.4		19	4	2.4	2.1	
Amphipoda:										
Hyperiidae	4	2	0.5	2.0						
Gammaridae:										
Gammarus sp.	17	6	1.4	13.9		3	2	1.2	1.1	
Lysianissidae	519	10	2.3	167.6	0.4					
Phronimidae:										
Phronima sp.	170	62	14.1	43.6		3	3	1.8	1.0	
Unidentified Phronimidae	2	2	0.5	0.3						
Caprellidae:										
Caprella sp.	2	1	0.2	0.1						
Unidentified Caprellidae	2	2	0.5	1.0						
Unidentified amphipods	139	29	6.6	34.4		33	9	5.4	4.7	
Euphausiacea:										
Euphausiidae:										
Euphausia sp.	67	5	1.1	11.5		93	2	1.2	27.0	
Unidentified euphausids	93	10	2.3	17.7		168	15	9.0	53.9	
Decapoda:										
Penaeidae:										
Penaeus sp.	1	1	0.2	1.4		71	5	3.0	116.8	
Unidentified Penaeidae	27	9	2.1	9.3		90	15	9.0	103.3	
Palaemonidae:										
Palaemon sp.	9	7	1.6	11.5		19	8	4.8	34.2	
Unidentified Palaemonidae	27	4	0.9	3.8		16	1	0.6	0.2	
Hippolytidae	1	1	0.2	7.5						
Nephropsidae:										
Enoplometopus sp.	7	3	0.7	2.5						
Unidentified Nephropsidae	2	1	0.2	0.5						
Palinuridae:										
Panulirus sp.	1	1	0.2	0.9						
Unidentified Palinuridae	1	1	0.2	0.8						
Megalopa larvae	212	31	7.1	42.0		1	1	0.6	0.1	
Phyllosoma larvae	2	2	0.5	0.2						
Unidentified decapods	48	10	2.3	36.4		47	4	2.4	38.5	
Stomatopoda										
Squillidae:										
Squilla sp.	6	4	0.9	1.4						
S. alba	1	1	0.2	0.2						
Pseudosquilla sp.	2	2	0.5	0.9						
P. occulta	6	3	0.7	3.5						
Lysiosquilla sp.	7	4	0.9	3.7						
Coronida sp.	2	2	0.5	0.6						
Gonodactylus sp.	10	8	1.8	2.6						
G. guerini	32	7	1.6	7.3						
Odontodactylus sp.	1	1	0.2	0.6						
O. hensenii	18	7	1.6	6.7						
Unidentified stomatopods	2	2	0.5	0.3						
Unidentified crustaceans	4	3	0.7	0.8		1	1	0.6	1.0	
MOLLUSCA										
Gastropoda	[3,537]			[16,275.2]	[36.4]	[910]			[7,997.3]	
Heteropoda										
Atlantidae	49	15	3.4	3.0		6	4	2.4	0.5	
Pterotracheidae:										
Pterotrachea sp.	1	1	0.2	0.3						
Unidentified heteropods	60	24	5.5	92.0	0.2					
Pteropoda										
Spiratellidae	2	2	0.5	0.7						
Unidentified pteropods	10	1	0.2	5.0						

See footnote at end of table.

11.—*Check-list of food organisms found in the stomachs of 439 yellowfin and 166 bigeye tuna captured on longline in the Central Pacific, 1950–53*—Continued

[Family names of fishes are as given in Berg 1947]

Food organisms	Yellowfin					Bigeye				
	Number of organisms	Stomachs in which occurred		Aggregate total volume		Number of organisms	Stomachs in which occurred		Aggregate total volume	
		Number	Percent	Cubic centimeters	Percent[1]		Number	Percent	Cubic centimeters	Percent[1]
oda										
da										
odidae:										
opus sp	2	1	0.2	20.0		2	1	0.6	7.7	
dentified Octopodidae	67	22	5.0	1,153.4	2.6	15	11	6.6	273.9	1.2
autidae:										
onauta sp	169	32	7.3	543.4	1.2	45	9	5.4	156.1	0.7
hians	72	8	1.8	273.2	0.6					
bettgeri	52	16	3.6	254.4	0.6	8	3	1.8	58.0	0.3
dentified argonauts	147	43	9.8	727.1	1.6	23	17	10.2	115.7	0.5
enidae:										
donnella sp	2	2	0.5	45.0	0.1	2	1	0.6	20.0	
ntified octopods	7	7	1.6	35.2		4	4	2.4	29.4	0.2
da (squid)	[2,738]	[382]	[87.0]	[13,036.4]	[29.2]	[770]	[137]	[82.5]	[7,311.3]	[32.8]
dae:										
sia sp						3	1	0.6	5.8	
dentified sepiidae	13	10	2.3	110.5	0.2	3	2	1.2	9.7	
ginidae:										
ico sp	2	1	0.2	3.8		10	3	1.8	62.8	0.3
ioteuthis sp	22	12	2.7	382.3	0.9	26	7	4.2	1,080.0	4.8
dentified Loliginidae	333	59	13.4	2,205.0	4.9	85	24	14.5	1,252.8	5.6
dae	7	5	1.1	277.8	0.6	9	5	3.0	334.0	1.5
oteuthidae:										
ycoteuthis sp.										
benksi						2	2	1.2	147.0	0.7
roteuthis sp	6	1	0.2	14.0						
dentified Onycoteuthidae	2	2	0.5	4.5		8	2	1.2	99.3	0.4
oteuthidae:										
diteuthis sp	1	1	0.2	4.0						
dentified Histioteuthidae	10	5	1.1	14.2		6	3	1.8	34.0	0.2
oteuthidae:										
alia sp						8	2	1.2	41.0	0.2
astrosticta	4	1	0.2	14.2						
ploteuthis sp	31	4	0.9	81.5	0.2	5	3	1.8	56.5	0.3
dentified Enoploteuthidae	162	67	15.3	397.4	0.9	77	35	21.1	414.8	1.9
strephidae:										
odarus sp	40	9	2.1	179.9	0.4	2	1	0.6	120.0	0.5
mastrephes sp	16	1	0.2	85.0	0.2					
dentified Ommastrephidae	923	175	39.9	3,534.6	7.9	205	42	25.3	2,482.0	11.1
hiidae:										
ocranchia sp	1	1	0.2	2.7		1	1	0.6	1.8	
ranchia sp						95	4	2.4	131.0	0.6
obulus	61	7	1.6	116.1	0.3	74	3	1.8	207.8	0.9
tentified Cranchiidae	10	2	0.5	17.0						
ntified squid	1,094	143	32.6	5,591.9	12.5	151	48	28.9	830.9	3.7
sified cephalopods	159	32	7.3	86.1	0.2	35	5	3.0	4.9	
HORDATA										
	[375]	[106]	[24.1]	[264.7]	[0.6]	[41]	[10]	[6.0]	[21.8]	
a										
ae:										
a sp	19	1	0.2	1.1						
tentified Salpidae	349	106	24.1	238.0	0.5	36	7	4.2	9.4	
ea										
omatidae	6	4	0.9	23.6		3	2	1.2	11.5	
ified tunicates	1	1	0.2	2.0		2	2	1.2	0.9	
(Pisces)	[4,340]	[408]	[92.9]	[27,643.5]	[61.9]	[1,702]	[140]	[84.3]	[13,890.2]	[62.3]
tomidae (viperfishes):										
othone sp						2	1	0.6	2.0	
eiguerria lucetia	110	2	0.5	44.4		181	3	1.8	32.8	0.1
tentified Gonostomidae						1	1	0.6	2.1	
optychidae (hatchetfishes):										
hoptyx sp	4	2	0.5	2.2		29	2	1.2	14.8	
diaphana	253	2	0.5	517.1	1.2	118	1	0.6	75.0	0.3
uropelecus sp.										
haemigymnus						4	1	0.6	14.3	
identified Sternoptychidae	81	11	2.5	83.1	0.2	82	13	7.8	65.0	0.3
niatidae	13	4	0.9	12.0		3	2	1.2	1.6	
uliodontidae						1	1	0.6	5.0	
onesthidae	1	1	0.2	0.2						
nostomiatidae	1	1	0.2	43.5						
dae:										
dis sp	1	1	0.2	3.6		4	2	1.2	76.1	0.3
ralepis sp						27	5	3.0	216.0	1.0
stidium sp	1	1	0.2	2.5		24	2	1.2	123.0	0.6
undum						6	1	0.6	17.5	
nidentified Sudidae	47	28	6.4	197.9	0.4	44	18	10.8	214.8	1.0
isauridae (lancet fishes):										
episaurus sp	41	16	3.6	172.3	0.4	36	17	10.2	635.4	2.8
elidae (lantern fishes)	57	21	4.8	94.5	0.2	21	7	4.2	127.1	0.6
raenidae	6	1	0.2	1.4						

footnote at end of table.

TABLE 11.—*Check-list of food organisms found in the stomachs of 439 yellowfin and 166 bigeye tuna captured on long the Central Pacific, 1950–53*—Continued

[Family names of fishes are as given in Berg 1947]

Food organisms	Yellowfin					Bigeye				
	Number of organisms	Stomachs in which occurred		Aggregate total volume		Number of organisms	Stomachs in which occurred		Aggregate volu	
		Number	Percent	Cubic centimeters	Percent [1]		Number	Percent	Cubic centimeters	
Vertebrata—Continued										
Nemichthyidae (snipe eels)	3	1	0.2	3.4		1	1	0.6	0.5	
Belonidae (needle fishes)	13	6	1.4	10.7		7	6	3.6	12.0	
Hemirhamphidae (halfbeaks)	1	1	0.2	7.0						
Exocoetidae (flying fishes):										
Cypselurus sp.	5	4	0.9	321.3	0.7					
Paraexocoetus sp.	2	1	0.2	31.5						
Unidentified Exocoetidae	27	13	3.0	295.3	0.7	6	5	3.0	64.8	
Bregmacerotidae:										
Bregmaceros macclellandi	4	3	0.7	6.6		1	1	0.6	1.0	
Gadidae (codfishes)	1	1	0.2	1.9						
Lophotidae (oarfishes)						1	1	0.6	2.8	
Trachypteridae (ribbon fishes):										
Trachypterus sp.						2	1	0.6	40.0	
Regalecidae (oarfishes):										
Regalecus sp.						1	1	0.6	190.0	
Berycidae	10	3	0.7	45.0	0.1	1	1	0.6	3.9	
Diretmidae	1	1	0.2	94.0	0.2					
Caulolepidae:										
Anoplogaster sp.	5	2	0.5	21.6						
A. cornutus						9	2	1.2	21.0	
Unidentified Caulolepidae	27	3	0.7	94.0	0.2	1	1	0.6	6.4	
Holocentridae (squirrel fishes):										
Holocentrus sp.	2	1	0.2	0.2						
Unidentified Holocentridae						1	1	0.6	0.1	
Zeidae (John Dories):										
Allocytus sp.	2	2	0.5	5.3						
Caproidae:										
Antigonia sp.										
A. capros						11	1	0.6	33.0	
Atherinidae (silversides):										
A. insularum						150	1	0.6	55.4	
Polynemidae (threadfins)	1	1	0.2	7.2						
Priacanthidae (catalufas):										
Pricanthus cruentatus	2	1	0.2	29.5						
Pseudopriacanthus sp.						1	1	0.6	6.8	
Apogonidae (cardinal fishes):										
Parascombrops pellucida	1	1	0.2	0.6						
Scombropidae:										
Hypoclydonia sp.	7	2	0.5	6.9		4	1	0.6	9.2	
Scombrops sp.	8	2	0.5	4.6		1	1	0.6	1.9	
Unidentified Scombropidae						1	1	0.6	1.2	
Carangidae (jacks):										
Seriola sp.	1	1	0.2	88.0	0.2					
Naucrates sp.	1	1	0.2	118.0	0.3					
Carangus sp.										
Scomboides sp.	1	1	0.2	115.7	0.3	1	1	0.6	8.6	
Unidentified Carangidae	1	1	0.2	1.8						
Bramidae (pomfrets):										
Collybus drachme	1,012	190	43.3	3,465.9	7.8	76	26	15.7	2,550.8	
Taractes sp.	88	33	7.5	786.3	1.8	34	22	13.3	835.5	
Pteraclis sp.	1	1	0.2	3.0						
P. ocellatus	2	1	0.2	4.2		1	1	0.6	14.8	
Unidentified Bramidae	244	66	15.0	675.2	1.5	18	10	6.0	476.9	
Coryphaenidae (dolphins):										
Coryphaenus sp.	2	2	0.5	118.1	0.3					
C. hippurus	3	1	0.2	1.4						
Unidentified Coryphaenidae	2	2	0.5	3.3		3	2	1.2	2.6	
Lutianidae (snappers)	1	1	0.2	1.5						
Leiognathidae	8	1	0.2	21.0						
Mullidae (goat fishes):										
Pseudupeneus sp.										
P. porphyreus										
Unidentified Mullidae	1	1	0.2	1.2						
Chaetodontidae (butterfly fishes)						1	1	0.6	3.7	
Pomacentridae (damsel fishes)	5	3	0.7	29.3						
Champsodontidae: *Champsodon* sp.	3	2	0.5	4.4		1	1	0.6	7.0	
Chiasmodontidae	26	10	2.3	39.5		1	1	0.6	2.0	
Acanthuridae (surgeon fishes):	12	3	0.7	24.8		7	3	1.8	29.9	
Hepatus sp.										
Unidentified Acanthuridae	6	1	0.2	12.8						
Zanclidae (Moorish Idol)	31	10	2.3	97.9	0.2					
Gempylidae (snake mackerels):	1	1	0.2	21.9						
Gempylus serpens	202	80	18.1	2,119.5	4.7	86	43	25.9	2,023.7	
Ruvettus sp.	1	1	0.2	0.4		2	1	0.6	2.4	
Neolotus tripes	10	1	0.2	21.5		1	1	0.6	4.4	
Promethichthys prometheus	7	1	0.2	36.0						
Neoephinnula orientalis						1	1	0.6	5.5	
Rexea solandri						2	1	0.6	2.8	
Mimasea taeniosoma						18	1	0.6	80.0	
Unidentified Gempylidae	1	1	0.2	1.8		48	18	10.8	376.3	
	149	62	14.1	786.2	1.8					

See footnote at end of table.

11.—*Check-list of food organisms found in the stomachs of 439 yellowfin and 166 bigeye tuna captured on longline in the Central Pacific, 1950–53*—Continued

[Family names of fishes are as given in Berg 1947]

Food organisms	Yellowfin					Bigeye				
	Number of organisms	Stomachs in which occurred		Aggregate total volume		Number of organisms	Stomachs in which occurred		Aggregate total volume	
		Number	Percent	Cubic centimeters	Percent [1]		Number	Percent	Cubic centimeters	Percent [1]
a—Continued										
bridae (mackerels):										
mber sp.	9	2	0.5	21.4						
identified Scombridae	4	3	0.7	68.6	0.2					
eidae (rudder fishes):										
meus sp.	41	16	3.6	102.3	0.2	34	6	3.6	76.9	0.3
piceps sp.	14	4	0.9	30.8		8	3	1.8	22.8	0.1
hompsoni	2	1	0.2	10.0						
ges sp.	41	12	2.7	79.0	0.2	4	2	1.2	10.4	
nodactylus sp.						1	1	0.6	5.6	
dentified Nomeidae	58	25	5.7	122.6	0.3	15	10	6.0	75.0	0.3
nnidae (tuna fishes):										
di sp.						3	1	0.6	17.5	
sawonus pelamis	48	17	3.9	3,497.1	7.8					
thunnus macropterus	2	2	0.5	962.0	2.2	1	1	0.6	662.0	3.0
mo alalunga	1	1	0.2	22.2						
ris thazard	68	12	2.7	1,964.0	4.4	2	2	1.2	224.0	1.0
rathunnus sibi	1	1	0.2	70.0	0.2					
dentified Thunnidae	6	4	0.9	12.2		1	1	0.6	1.0	
neidae (remoras):										
neis sp.	16	8	1.8	144.8	0.3					
noropsis brachypterus	4	2	0.5	26.6						
ncra sp.	4	3	0.7	14.3						
remora	12	11	2.5	145.8	0.3					
dentified Echeneidae	26	20	4.6	116.3	0.3	7	3	1.8	5.6	
tidae (trigger fishes):										
istes sp.	8	5	1.1	72.6	0.2					
nycteris	23	12	2.7	412.5	0.9					
ringens	5	3	0.7	134.0	0.3					
nthichthys sp.	1	1	0.5	6.8						
dentified Balistidae	8	7	1.6	71.9	0.2					
canthidae (file fishes)	11	7	1.6	27.8						
idae (trunk fishes):										
acion sp.	33	14	3.2	78.3	0.2	15	2	1.2	23.0	0.1
raphanus	78	29	6.6	322.7	0.7	8	2	1.2	29.7	0.1
storia sp.	3	3	0.7	15.3		1	1	0.6	2.5	
schlemmeri	18	13	3.0	243.4	0.5	2	2	1.2	69.5	0.3
dentified Ostraciidae	11	10	2.3	27.1		1	1	0.6	0.6	
dontidae (puffers):										
oeroides lagocephalus	9	6	1.4	77.0	0.2					
cephalus sp.	3	2	0.5	57.5	0.1					
don sp.	3	2	0.5	215.7	0.5					
dentified Tetrodontidae	7	7	1.6	118.1	0.3	1	1	0.6	16.6	
ntidae (porcupine fishes):										
on sp.	1	1	0.2	10.0						
lomycteris sp.	5	5	1.1	66.1	0.1					
-linis	3	1	0.2	54.0	0.1					
dentified Diodontidae	13	10	2.3	162.3	0.4	1	1	0.6	0.1	
ae (sun fishes):										
ania sp.	19	12	2.7	4,318.8	9.7	1	1	0.6	113.0	0.5
dentified Molidae						2	2	1.6	151.0	0.7
naridae (frogfishes):										
nnarius sp.	1	1	0.2	0.8						
unidentified fish	1,160	213	48.5	2,968.9	6.6	511	81	48.8	3,884.0	17.4
				44,679.5					22,297.3	
stomachs examined				439					166	

n only when 0.1 percent or greater.

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Some Unusual Fishes From the Central Pacific

JOSEPH E. KING and ISAAC I. IKEHARA[1]

PURPOSE OF THIS ARTICLE is to call the ation of ichthyologists to certain rare or mmon fishes recently collected in the ral Pacific by staff members of the Pacific anic Fishery Investigations at Honolulu, others. These fishes have been deposited the U. S. National Museum. The photo- hs included here were taken by E. D. up; Figure 4 was prepared by Tamotsu ata.

SQUALIDAE

he first two species, here placed in the lidae following Hubbs and McHugh 1), were formerly placed in the Dalatiidae, Bigelow and Schroeder (1948).

protomicrus bispinatus (Quoy and aimard)

e female specimen (Fig. 1) (USNM No. 6), 161 mm. in total length. Collected h 3, 1948, about 340 miles WNW of ton Island at 18°24′N., 175°12′W. in about 1,000 fathoms deep. Attracted to t and dip-netted at surface. Collected by . Schaefer aboard M/V "Oregon" oper- by Pacific Exploration Company.

escription: No anal fin; 2 dorsal fins with- spines; snout blunt and broadly rounded; ll openings, all anterior to pectorals; body nearly cylindrical; eyes lateral without nictitating membrane; a large spiracle present; mouth transverse with a groove extending posteriorly from each end; teeth with only 1 cusp and not serrated; upper teeth narrowly triangular and needle-pointed, lower teeth broader, compressed, and bent outwards; caudal axis scarcely upturned; no subterminal notch evident; end of base of first dorsal fin well in advance of the pelvic insertion; base of second dorsal fin very much longer than that of the first; denticles quadrate, with a central pit; first dorsal fin very much nearer pelvic base than pectoral base; body uniform brownish black (in alcohol after fixation in formalin), outer edges of fins clear. Measurements of the specimen and proportional measurements as per cent of total length are given in Table 1.

Hubbs and McHugh (1951) report the capture of a female *E. bispinatus*, 233 mm. total length, about 500 miles off the California coast. They give a thorough description of the specimen and state that it is ". . . the only extant example of the genus known from the Pacific Ocean and, so far as we know, the only one in an American museum." An earlier specimen collected in the open Pacific "between Honolulu and San Francisco, but nearer to the former" (Eigenmann, 1891) was destroyed in the San Francisco fire, according to Hubbs and McHugh. Since we can find no record of any capture of this species since

[1] Fishery Research Biologists, Pacific Oceanic Fishery Investigations, U. S. Fish and Wildlife Service, Honolulu, T. H. Manuscript received April 13, 1955.

TABLE 1

BODY MEASUREMENTS AND PROPORTIONAL MEASUREMENTS OF *Euprotomicrus bispinatus* AND *Isistius brasi*
(Body Measurements in Millimeters, Proportional Measurements [bracketed] in Percentage of Total Leng

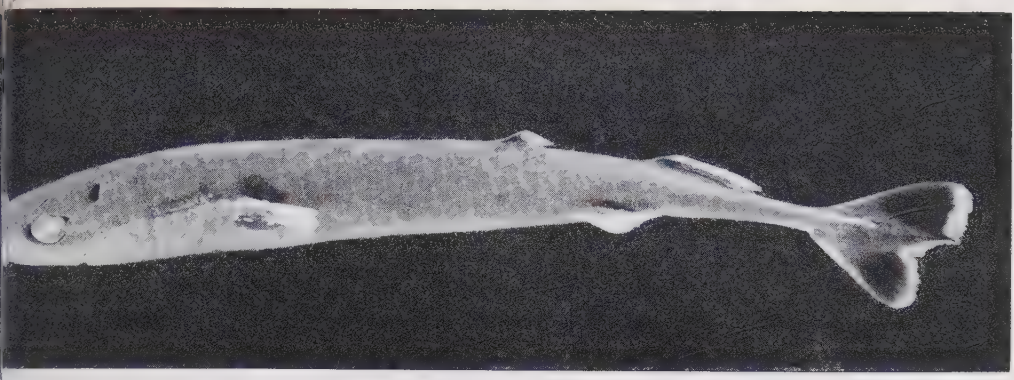
	*E. bispinatus**	*I. brasiliensis*†
Trunk at origin of pectoral: breadth	19.0 (11.8)	21.0 (11.1)
height	17.0 (10.6)	19.5 (10.3)
Snout length in front of: outer nostrils	3.0 (1.9)	1.5 (0.8)
mouth	17.0 (10.6)	13.0 (6.9)
Eye: horizontal diameter	6.0 (3.7)	8.0 (4.2)
Mouth: breadth	11.0 (6.8)	10.5 (5.6)
height	1.0 (0.6)	0.0 (0.0)
Nostrils: distance between inner ends	4.0 (2.5)	3.0 (1.6)
Labial furrow length from angle of upper jaw	8.0 (5.0)	11.0 (5.8)
Gill opening lengths: 1st	2.0 (1.2)	2.0 (1.1)
2nd	2.0 (1.2)	2.0 (1.1)
3rd	2.0 (1.2)	2.0 (1.1)
4th	1.5 (0.9)	1.5 (0.8)
5th	1.0 (0.6)	1.0 (0.5)
First dorsal fin: vertical height	2.5 (1.6)	4.0 (2.1)
length of base	2.5 (1.6)	6.0 (3.2)
Second dorsal fin: vertical height	3.3 (2.0)	4.0 (2.1)
length of base	14.0 (8.7)	7.0 (3.7)
Caudal fin: upper margin	25.0 (15.5)	27.0 (14.3)
lower anterior margin	20.0 (12.4)	20.0 (10.6)
Pectoral fin: outer margin	16.5 (10.2)	16.0 (8.5)
inner margin	10.5 (6.5)	11.0 (5.8)
distal margin	13.0 (8.1)	6.8 (3.6)
Distance from snout to: 1st dorsal	84.0 (52.2)	115.5 (61.1)
2nd dorsal	108.0 (67.1)	136.5 (72.2)
upper caudal	137.0 (85.1)	164.0 (86.8)
pectoral	40.0 (24.8)	42.0 (22.2)
ventrals	94.0 (58.4)	122.5 (64.8)
Interspace between: 1st and 2nd dorsals	21.0 (13.0)	16.7 (8.8)
2nd dorsal and caudal	16.0 (9.9)	20.5 (10.8)
Distance from origin to origin of: pectoral and ventrals	56.5 (35.1)	84.5 (44.7)
ventrals and caudal	41.0 (25.5)	41.0 (21.7)

* Female, 161 millimeters in total length.
† Female, 189 millimeters in total length.

1951, we believe that our specimen is the third example of the genus (monotypic) known from the Pacific and the second example in an American collection.

2. **Isistius brasiliensis** (Quoy and Gaim

One male specimen (USNM No. 1641 165 mm. in total length. Collected Marc



. 1. Lateral view of a 161 millimeter (female) *Euprotomicrus bispinatus* captured at the surface with a dip net 4′N., 175°12′W.

. 2. Lateral view of a 189 millimeter (female) *Isistius brasiliensis* captured by pelagic trawl at 2°09′N., 158°

at about 11 P.M. aboard M/V "Hugh ith" at 2°04′S., 168°57′W., in water 3,000 fathoms deep. Collected by Yuen employing a 1-meter (mouth er) zooplankton net in an oblique haul meters depth.

emale specimen (USNM No. 164175), m. in total length. Collected May 23, at about 8:30 P.M. aboard M/V "John anning" at 4°47′N., 161°04′W., in water 2,000 fathoms deep. Collected by J. E. and T. S. Hida in a 6-foot Isaacs-Kidd depth of haul about 100 meters.

second female (Fig. 2) (USNM No. 4), 189 mm. in total length. Collected June 2, 1954, at about 8:30 P.M., aboard M/V "John R. Manning" at 2°09′N., 158°14′W., in water about 1,000 fathoms deep. Collected by J. E. King and T. S. Hida in a 6-foot Isaacs-Kidd trawl with depth of haul about 100 meters. Measurements of this specimen are given in Table 1.

Description: No anal fin; 2 dorsal fins, without spines; snout blunt and broadly rounded; 5 gill openings, all anterior to pectorals; body nearly cylindrical; eyes lateral, without nictitating membrane; a large spiracle present; teeth with only 1 cusp and faint indications of serration; teeth of the upper and lower jaw very unlike, the upper are slender and curved

outwards while the lower are much larger and erect, with subquadrate bases and triangular sharp-pointed cusp; caudal axis scarcely upturned; subterminal notch in caudal fin slight; mouth transverse, with fleshy lips and a groove extending backwards and outwards from each end; unlike *E. bispinatus*, the first dorsal fin is displaced backward so that the end of its base is over the origin of the pelvic base; dorsal fin bases nearly equal; denticles quadrate with a median pit; first dorsal fin very much nearer pelvics than pectoral base; body dark brown above (in alcohol after fixation in formalin), pale grayish brown below except for a dark collar across the throat; fins with outer edges clear except the upper lobe of the caudal, which is brown to the margin.

This small oceanic shark, although uncommon, is not nearly as rare as *E. bispinatus*. According to Bigelow and Schroeder (1948), *I. brasiliensis* is distributed throughout the tropical and subtropical belts of all three oceans; however, records of its occurrence in the eastern and central Pacific are few. One specimen was taken by the "Albatross" (Garman 1899) at 2°34′N., 92°06′W. F. D. Bennett (1840) captured two specimens, which he classified as *Squalus fulgens*, in a net towed at the surface; one of these, 10 inches in length, he reported as taken at 2°30′S., 163° W., and the other, 18 inches in length, at 55°N., 110°W. Garman (1899) pointed out the obvious error in the latter position and stated that the actual longitude was 140°W. Later G. Bennett (1860) collected a 5.5-inch specimen, which he classified as *Scymmus* sp., at 2°15′S., 163°W. Jordan and Jordan (1922) report the occurrence of this small shark in Hawaiian waters under the name *Apristurus spongiceps* (Gilbert). Fowler and Ball (1925) state that a specimen classified earlier (Fowler 1923) as *Echinorhinus brucus* (Bonnaterre) in Bernice P. Bishop Museum collections from Hawaiian waters is actually *I. brasiliensis*. All the above names are placed in synonymy with *I. brasiliensis* by Bigelow and Schroeder (1948).

The Bennetts' description of the luminiscence of this fish has been quoted o This characteristic was not observed in three specimens, possibly because all t were dead when brought on deck. The miniscence is reported to fade out as the dies.

LOPHOTIDAE

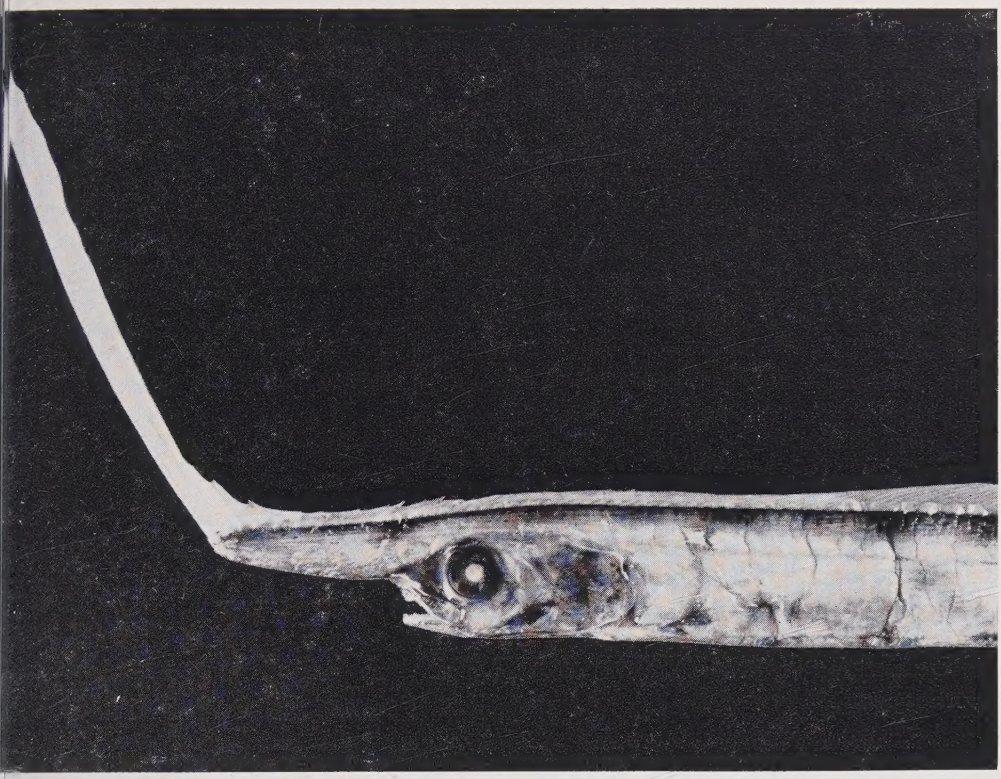
3. **Eumecichthys fiski** (Günther) Regar

One specimen (Figs. 3 and 4) (USNM 164170), 598 mm. in standard length. lected June 1, 1954, at about 12:15 aboard M/V "John R. Manning" at 3°04 159°13′W., in water about 900 fathoms d Dip-netted at the surface by Howard mauu, fisherman on the "Manning."

Description: Body elongate, strongly c pressed, nearly of uniform depth through scaleless, snout prolonged as a sword-sha process bearing near its tip a pronou plume or crest (Fig. 3); dorsal fin comme at the tip of this process with an extre long and compressed ray, then continue the caudal averaging in height about fourth the body depth; both jaws are ar with small, hooked teeth; premaxillary protractile; eye large; no ventral fins; ana rudimentary, base about 3 mm., height than 1 mm. (Fig. 4); body silvery (in alc after fixation in formalin) with about 30 bars or blotches, most prominent dors occipital crest and dorsal and caudal fins crimson in life but faded completely in malin.

Fin ray count: D. 326; P. 13(R), 12(L); C

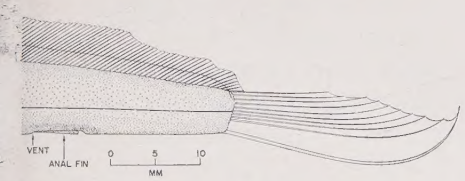
Body measurements (in millimeters) proportional measurements (bracketed) percentage of standard length: snout to v 579.0 (96.7); vent to base of caudal, (3.4); caudal fin length, 25.5 (4.3); l length including snout, 64.0 (10.7); si length in front of mouth, 30.0 (5.0); si to origin of pectoral, 64.0 (10.7); grea body height, 21.3 (3.6); greatest body brea 7.0 (1.2); pectoral fin length, 13.0 (pectoral fin base, 5.0 (0.8); dorsal fin he at mid-point of body, 6.0 (1.0); dorsal



. 3. Head portion of a 625 millimeter specimen of *Eumecichthys fiski* captured at the surface in a dip net at N., 159°13'W.

t at origin of pectoral, 4.0 (0.7); dorsal ght above vent, 5.0 (0.8); crest height, (13.9); eye diameter, 8.0 (1.3).

ails of the capture of this rare fish are ps of interest. About midday shortly tarting to haul longline, we (J. E. King S. Hida) noticed a thin "shadow" near rface just to the rear of the point where e was emerging from the water. When ally decided that this was not just the wake or the shadow of the line but an unusual object in the water, a dip net was hastily obtained and this very rare fish was scooped from the water. After it had lain on a canvas hatch cover for a few minutes, we noticed that a black fluid had been discharged from the vent. Kershaw (1909) and Griffin (1934) have reported that lophotid fishes may emit an inky fluid from the vent when captured.



. 4. Tail portion of *Eumecichthys fiski*, same spec- as in Figure 3, with the caudal fin expanded to the detailed structure of the fin.

Eumecichthys fiski was described by Günther (1890) as *Lophotes fiski* from a 50-inch specimen that washed up on the shore of Kalk Bay (Atlantic Ocean), South Africa. In this fish the caudal region was mutilated so that Günther did not know the nature of the caudal fin nor whether or not an anal fin was normally present. Apparently no additional examples had appeared in South Africa by the time of the recent revision of "The Sea Fishes

of South Africa" by Smith (1953). From our examination of available literature, we conclude that all subsequent collections of *E. fiski*, except for our specimen from the central Pacific, have been from Japanese waters. Kamohara (1949) states that "In Japan a specimen 88.1 cm. in length was collected off Kōchi in 1939 by a worker from the Kōchi Prefectural Fisheries Experiment Station and was reported by Dr. Kiyomatsu Matsubara. This was the first record from Japan. Thereafter it transpired that several specimens had been captured in 1937 off Hagi in Yamaguchi Prefecture, and that it had also been collected earlier in Wakayama Prefecture." [Translated from the Japanese by W. G. Van Campen.] There is no reference to this species in *The Fishes of Oceania* (Fowler, 1928) and its supplements, or in *The Fishes of the Indo-Australian Archipelago*, Vol. V (Weber and De Beaufort, 1929), which includes the Allotriognathi.

TRACHYPTERIDAE

4. ? **Trachypterus iris** (Walbaum)

Two specimens (USNM No. 164172), both juveniles; one 84 mm. in standard length (caudal fin broken), the other 109 mm. in standard length (146 mm. total length with caudal depressed to the horizontal). Collected May 4, 1953, at about 8 P.M. aboard M/V "John R. Manning" at 8°32′N., 150°12′W., in water about 2,700 fathoms deep. Collected by W. F. Royce and W. M. Matsumoto in a 10-foot Isaacs-Kidd trawl; depth of haul about 200 meters.

Description: Body elongate, strongly compressed, scaleless; dorsal fin extends length of body; caudal fin divided, the larger portion pointing upwards; rays of dorsal bear numerous spinules; lateral line spinous; vent located on mid-ventral line in contrast to the following species; anterior profile steep, almost vertical; mouth protractile; body pale colorless (in alcohol after fixation in formalin).

Fin ray count: D. 160 ± 2; P. (broken); V. 5; C. 7 (upper), 5 (lower).

Body measurements (in millimeters) proportional measurements (bracketed percentage of standard length (109 m snout to vent, 70.0 (64.2); vent to bas caudal, 42.0 (38.5); caudal fin length, (31.2); greatest body height, 18.0 (1 greatest body breadth, 6.0 (5.5).

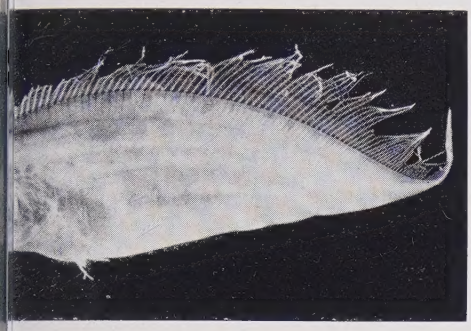
5. ? **Trachypterus woodi** Smith

One specimen (Fig. 5) (USNM No. 171), a juvenile, 113 mm. standard le (125 mm. in total length with caudal pressed to the horizontal). Collected Ma 1954, at about 8:30 P.M. aboard M/V " R. Manning" at 4°41′N., 159°53′W., in v about 2,000 fathoms deep. Collected by King and T. S. Hida in a 6-foot Isaacs-K trawl; depth of haul about 100 meters.

Description: Body strongly compressed; sal fin extends length of body; rays of d with numerous spinules, each ray with a of larger spines near its base; rays at ant end of dorsal show evidence of having l prolonged but are now broken; anterior file steep but less than vertical; body cov with small, smooth tubercles, particu prominent in the ventral region; lateral spinous; no anal fin; caudal fin turned wards, with no downward projecting por as in previous specimen; vent located on side of body about 2 mm. above mid-ve line (the asymmetrical location of vent i *misakiensis* was pointed out by Herre Herald in 1950); body silvery (in alc after fixation in formalin) with scattered blotches below dorsal and perhaps s small blotches extending posteriorly in a beginning at the upper margin of the fins pink in life, clear in alcohol.

Fin ray count: D. 144, P. 12, V. 9, C. 8

Body measurements (in millimeters) proportional measurements (bracketed) percentage of standard length: snout to v 78.5 (69.5); vent to base of caudal, 34.0 (30 caudal length, 12.5 (11.0); head length, (19.4); eye diameter, 7.3 (6.4); snout to or pectorals, 19.0 (16.7); snout to origin



5. Lateral view of *?Trachypterus woodi* Smith
l by pelagic trawl at 4°41′N., 159°53′W.

23.0 (20.3); greatest body height, 38.0
; greatest body breadth, 8.0 (7.0);
st height of dorsal fin, 18.0 (15.9).
st of the trachypterids examined by
ologists have been washed up on shore
ually were in poor condition; our spec-
are among the few to be collected in
and one of the three, at least, is in
nt condition. These fishes are noted for
hange in body proportions during de-
ment after the postlarval period (Hubbs,
The juveniles are particularly difficult
tify. On the basis of available literature
ve decided that two of our specimens
st likely *T. iris* (Walbaum), which is
ally a Mediterranean species, whereas
d resembles *T. woodi* Smith. Although
ntification is not certain due to limited
facilities and lack of sufficient reference
l, our description, measurements, and
ompanying figure may provide some
hile information to those who are in-
in the life history of these unusual

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